

N40003.AR.002365
PUERTO RICO NS
5090.3a

DRAFT FINAL STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT FOR
SOLID WASTE MANAGEMENT UNIT 2 NAVAL ACTIVITY PUERTO RICO (DRAFT ACTING
AS FINAL)
12/4/2009
CH2M HILL

Draft

Steps 6 and 7 of the Baseline Ecological Risk Assessment
SWMU 2
Naval Activity Puerto Rico
RCRA/HSWA Permit No. PR21700027203
Ceiba, Puerto Rico



Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia
Under the
LANTDIV CLEAN Program
Contract No. N62470-02-D-3052
CTO-0108

December 4, 2009

Prepared by



Federal Group, Inc.

Baker
Environmental, Inc.

CDM
Federal Programs Corp.

DRAFT

**STEPS 6 AND 7 OF THE
BASELINE ECOLOGICAL RISK ASSESSMENT
SWMU 2**

**NAVAL ACTIVITY PUERTO RICO
RCRA/HSWA PERMIT NO. PR2170027203
CEIBA, PUERTO RICO**

CONTRACT TASK ORDER 108

DECEMBER 4, 2009

Prepared for:

**DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
*Norfolk, Virginia***

Under the:

**LANTDIV CLEAN PROGRAM Program
Contract N62470-02-D-3052**

Prepared by:

**BAKER ENVIRONMENTAL, INC.
*Coraopolis, Pennsylvania***

**CH2M Hill
*Herndon, Virginia***

I certify under penalty of law that I have examined and am familiar with the information submitted in this document and all attachments and that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gather and present the information contained therein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information, that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowingly and willfully submitting a materially false statement.

Signature _____

Name: _____

Title: _____

Date: _____

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
LIST OF ACRONYMS AND ABBREVIATIONS	x
EXECUTIVE SUMMARY	ES-1
1.0 INTRODUCTION	1-1
2.0 BERA PROBLEM FORMULATION AND STUDY DESIGN	2-1
2.1 SWMU 2 Description	2-1
2.2 Environmental Setting	2-1
2.2.1 Terrestrial Habitats	2-2
2.2.2 Aquatic Habitats	2-2
2.2.3 Biota.....	2-4
2.3 Ecological Chemicals of Concern.....	2-7
2.4 Conceptual Model.....	2-9
2.4.1 Contaminant Fate and Transport and Toxicity Evaluation	2-10
2.4.2 Transport and Exposure Pathways.....	2-22
2.4.3 Assessment Endpoints and Risk Questions	2-23
2.5 BERA Study Design/Data Quality Objectives	2-26
2.5.1 Measurement Endpoints	2-26
2.5.2 BERA Study Design	2-28
2.5.3 Data Quality Objectives.....	2-30
2.5.4 Data Evaluation and Interpretation.....	2-31
3.0 FIELD INVESTIGATION SUMMARY	3-1
3.1 Verification of BERA Field Sampling Design	3-1
3.1.1 Terrestrial Habitat.....	3-2
3.1.2 Estuarine Wetland Habitat.....	3-4
3.1.3 Open Water Habitat	3-5
3.2 BERA Field Investigation.....	3-7
3.2.1 Soil Sampling in Support of Earthworm Toxicity Tests.....	3-7
3.2.2 Earthworm Toxicity Testing.....	3-9
3.2.3 Earthworm Tissue.....	3-10
3.2.4 Estuarine Wetland Sediment Sampling	3-10
3.2.5 Amphipod and Polychaete Toxicity Testing.....	3-12
3.2.6 Fiddler Crab Tissue Sampling	3-12
3.2.7 Seagrass Tissue and Co-Located Sediment Sampling	3-13
3.3 Quality Assurance/Quality Control Sampling	3-14
3.4 Data Evaluation and Validation.....	3-14
3.4.1 Verification of BERA Field Sampling Design	3-15
3.4.2 BERA Field Investigation.....	3-16
3.4.3 Validation Summary	3-18
4.0 ANALYTICAL AND TOXICITY TEST RESULTS AND DATA ANALYSIS	4-1
4.1 Verification of BERA Field Sampling Design	4-1
4.1.1 Upland Reference Areas	4-1
4.1.2 Estuarine Wetland Reference Area.....	4-12
4.1.3 Open Water Reference Areas	4-15

TABLE OF CONTENTS (continued)

4.2	BERA Field Investigation.....	4-18
4.2.1	Quick-Turn Soil Samples.....	4-19
4.2.2	Earthworm Toxicity Test Soil Samples	4-22
4.2.3	Earthworm Tissue.....	4-28
4.2.4	Quick-Turn Estuarine Wetland Sediment Samples	4-31
4.2.5	Acid Volatile Sulfide and Simultaneously Extracted Metals Analytical Data.....	4-33
4.2.6	Amphipod and Polychaete Toxicity Test Sediment Samples	4-36
4.2.7	Fiddler Crab Tissue.....	4-47
4.2.8	Turtle Grass Tissue and Co-Located Sediment Samples.....	4-50
5.0	RISK CHARACTERIZATION.....	5-1
5.1	Terrestrial Invertebrates Communities	5-2
5.1.1	Comparison of Ecological COC Concentrations in Soil to Invertebrate- Based Soil Screening Values	5-2
5.1.2	Comparison of Site and Reference Area Earthworm Toxicity Test Results.....	5-3
5.1.3	Evidence of a Significant Correlation between Earthworm Toxicity Test Results and the Chemical/Physical Characteristics of Soil.....	5-4
5.2	Terrestrial Avian Omnivore Populations	5-4
5.3	Estuarine Wetland Benthic Invertebrate Communities.....	5-5
5.3.1	Comparison of Ecological COC Concentrations in Sediment to Sediment Screening Values	5-5
5.3.2	Comparison of SEM Sediment Concentrations with AVS Sediment Concentrations	5-6
5.3.3	Comparison of SWMU 2 and Reference Area Amphipod and Polychaete Toxicity Test Results	5-6
5.3.4	Evidence of a Significant Correlation between Amphipod and Polychaete Toxicity Test Results and the Chemical/Physical Characteristics of Sediment	5-7
5.4	Estuarine Wetland Avian Invertivore Populations	5-9
5.5	West Indian Manatees.....	5-10
6.0	CONCLUSIONS AND RECOMMENDATIONS.....	6-1
6.1	Conclusions.....	6-1
6.1.1	Terrestrial Invertebrate Communities	6-1
6.1.2	Terrestrial Avian Omnivore Populations	6-2
6.1.3	Estuarine Wetland Benthic Invertebrate Communities.....	6-2
6.1.4	Estuarine Wetland Avian Invertivore Populations	6-3
6.1.5	West Indian Manatees.....	6-4
6.2	Recommendations.....	6-4
7.0	UNCERTAINTIES	7-1
8.0	REFERENCES.....	8-1

LIST OF TABLES

2-1	List of Birds Reported from or Having the Potential to Occur at Naval Activity Puerto Rico
2-2	Screening-level Assessment Endpoints, Risk Questions, and Measurement Endpoints
2-3	Summary of Media and Samples Evaluated in the Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment
2-4	Ecological Chemicals of Concern Identified in Step 3a of the Ecological Risk Assessment
2-5	Surface Soil Analytical Data for Ecological Chemicals of Concern from the 1992 Supplemental Investigation, 1996 RCRA Facility Investigation, and 2004 Additional Data Collection Investigation
2-6	Subsurface Soil Analytical Data for Ecological Chemicals of Concern from the 1992 Supplemental Investigation and 2004 Additional Data Collection Investigation
2-7	Step 2 and Step 3a Screening-Level Risk Estimates for Terrestrial Invertebrate and Plant Exposures to Ecological Chemicals of Concern in SWMU 2 Surface Soil
2-8	Step 2 and Step 3a Screening-Level Risk Estimates for Terrestrial Invertebrate and Plant Exposures to Ecological Chemicals of Concern in SWMU 2 Subsurface Soil
2-9	Summary of Hazard Quotient Values for American Robin and Mourning Dove Dietary Exposures to Lead, Mercury, and Zinc in SWMU 2 Surface Soil
2-10	Summary of Hazard Quotient Values for American Robin and Mourning Dove Dietary Exposures to Copper, Lead, and Zinc in SWMU 2 Subsurface Soil
2-11	Estuarine Wetland Sediment Analytical Data for Ecological Chemicals of Concern from the 2003 and 2004 Additional Data Collection Investigations
2-12	Step 2 and Step 3a Screening-Level Risk Estimates for Aquatic Invertebrate Exposures to Ecological Chemicals of Concern in SWMU 2 Estuarine Wetland Sediment
2-13	Ensenada Honda Sediment Analytical Data for Ecological Chemicals of Concern from the 2003 Additional Data Collection Investigation
2-14	Ingestion-Based Toxicity Reference Values for Birds (Terrestrial Avian Omnivores and Aquatic Avian Invertivores)
2-15	Ingestion-Based Toxicity Reference Values for the West Indian Manatee
2-16	Decision Rules for the Baseline Ecological Risk Assessment
3-1	SWMU 2 and Reference Area Soil and Estuarine Wetland Sediment Sampling and Analytical Program: Verification of the Field Sampling Design
3-2	Analytical Methodology: Verification of the Field Sampling Design
3-3	Soil Screening Values for Metals, PAHs, and Organochlorine Pesticides
3-4	Open Water Reference Area Sediment Sampling and Analytical Program: Verification of the Field Sampling Design
3-5	Upland and Estuarine Wetland Sampling and Analytical Program: Baseline Ecological Risk Assessment Field Investigation
3-6	Analytical Methodology: Baseline Ecological Risk Assessment Field Investigation
3-7	Open Water Reference Area No. 2 Turtle Grass and Sediment Sampling and Analytical Program: Baseline Ecological Risk Assessment Field Investigation
3-8	Data Qualifier Definitions
4-1	SWMU 2 Surface Soil Analytical Results: Verification of the Field Sampling Design
4-2	SWMU 2 Subsurface Soil Analytical Results: Verification of the Field Sampling Design
4-3	Upland Reference Area No. 1 Surface Soil Analytical Results: Verification of the Field Sampling Design
4-4	Upland Reference Area No. 2 Surface Soil Analytical Results: Verification of the Field Sampling Design

LIST OF TABLES (continued)

4-5	Upland Reference Area No. 3 Surface Soil Analytical Results: Verification of the Field Sampling Design
4-6	Upland Reference Area No. 1 Subsurface Soil Analytical Results: Verification of the Field Sampling Design
4-7	Upland Reference Area No. 2 Subsurface Soil Analytical Results: Verification of the Field Sampling Design
4-8	Upland Reference Area No. 3 Subsurface Soil Analytical Results: Verification of the Field Sampling Design
4-9	Quality Assurance/Quality Control Analytical Results for Soil and Estuarine Wetland Sediment Collection Activities: Verification of the Field Sampling Design
4-10	SWMU 2 Estuarine Wetland Sediment Analytical Results: Verification of the Field Sampling Design
4-11	Estuarine Wetland Reference Area Sediment Analytical Results: Verification of the Field Sampling Design
4-12	Total Organic Carbon and Grain Size Analytical Data for SWMU 2 Estuarine Wetland Sediment Samples Collected During the 2003 Additional Data Collection Field Investigations
4-13	Open Water Reference Area No. 1 Sediment Analytical Results: Verification of the Field Sampling Design
4-14	Open Water Reference Area No. 2 Sediment Analytical Results: Verification of the Field Sampling Design
4-15	Open Water Reference Area No. 3 Sediment Analytical Results: Verification of the Field Sampling Design
4-16	Quality Assurance/Quality Control Analytical Results for Open Water Sediment Collection Activities: Verification of the Field Sampling Design
4-17	Total Organic Carbon and Grain Size Analytical Data for SWMU 2 Open Water Sediment Samples Collected During the 2003 Additional Data Collection Field Investigation
4-18	SWMU 2 Quick-Turn Surface Soil Analytical Results: Baseline Ecological Risk Assessment Field Investigation
4-19	SWMU 2 Quick-Turn Subsurface Soil Analytical Results: Baseline Ecological Risk Assessment Field Investigation
4-20	Upland Reference Area No. 2 Quick-Turn Surface Soil Analytical Results: Baseline Ecological Risk Assessment Field Investigation
4-21	Upland Reference Area No. 2 Quick-Turn Subsurface Soil Analytical Results: Baseline Ecological Risk Assessment Field Investigation
4-22	Quality Assurance/Quality Control Analytical Results for Soil and Sediment Collection Activities: Baseline Ecological Risk Assessment Field Investigation
4-23	Maximum, 95 Percent Upper Confidence Limit of the Mean, and Arithmetic Mean Hazard Quotient Values for Soil Invertebrate Exposures to Ecological Chemicals of Concern in SWMU 2 Surface and Subsurface Soil
4-24	<i>Eisenia fetida</i> Toxicity Test Results and Associated Analytical Data
4-25	Correlation Coefficient and Coefficient of Determination Values: Earthworm Survival and Weight Loss per Surviving Earthworm versus Soil Variables
4-26	SWMU 2 Earthworm Tissue Analytical Results (Wet Weight and Dry Weight Basis): Baseline Ecological Risk Assessment Field Investigation
4-27	Upland Reference Area No. 2 Earthworm Tissue Analytical Results (Wet Weight and Dry Weight Basis): Baseline Ecological Risk Assessment Field Investigation
4-28	Summary of 95 Percent Upper Confidence Limit of the Mean Hazard Quotient Values for American Robin Dietary Exposures to Ecological Chemicals of Concern in SWMU 2 Soil

LIST OF TABLES (continued)

- 4-29 Summary of Maximum Hazard Quotient Values for American Robin Dietary Exposures to Copper, Lead, and Mercury in SWMU 2 and Upland Reference Area No. 2 Soil
- 4-30 SWMU 2 Quick-Turn Estuarine Wetland Sediment Analytical Results: Baseline Ecological Risk Assessment Field Investigation
- 4-31 Estuarine Wetland Reference Area Quick-Turn Sediment Analytical Results: Baseline Ecological Risk Assessment Field Investigation
- 4-32 Maximum, 95 Percent Upper Confidence Limit of the Mean, and Arithmetic Mean Hazard Quotient Values for Benthic Invertebrate Exposures to Ecological Chemicals of Concern in SWMU 2 Estuarine Wetland Sediment
- 4-33 Acid Volatile Sulfide/Simultaneously Extracted Metals Analytical Data from the 2004 Additional Data Collection Field Investigation
- 4-34 Acid Volatile Sulfide/Simultaneously Extracted Metals Analytical Data: Baseline Ecological Risk Assessment Field Investigation
- 4-35 Simultaneously Extracted Metals –to-Acid Volatile Sulfide Ratios for Estuarine Wetland Sediment Collected during the 2004 Additional Data Collection and Baseline Ecological Risk Assessment Field Investigations
- 4-36 *Leptocheirus plumulosus* Toxicity Test Results and Associated Analytical Data
- 4-37 Correlation Coefficient and Coefficient of Determination Values: Amphipod Survival and Dry Weight per Surviving Amphipod versus Sediment, Overlying Water, and Pore Water Variables
- 4-38 *Neanthes arenaceodentata* Toxicity Test Results and Associated Analytical Data
- 4-39 Correlation Coefficient and Coefficient of Determination Values: Polychaete Survival versus Sediment, Overlying Water, and Pore Water Variables
- 4-40 SWMU 2 Fiddler Crab Tissue Data: Baseline Ecological Risk Assessment Field Investigation
- 4-41 Estuarine Wetland Reference Area Fiddler Crab Tissue Data: Baseline Ecological Risk Assessment Field Investigation
- 4-42 Summary of 95 Percent Upper Confidence Limit of the Mean Hazard Quotient Values for Spotted Sandpiper Dietary Exposures to Lead and Mercury in SWMU 2 Estuarine Wetland Sediment
- 4-43 SWMU 2 Turtle Grass Tissue Analytical Results (Wet Weight and Dry Weight Basis): Baseline Ecological Risk Assessment Field Investigation
- 4-44 Open Water Reference Area No. 2 Turtle Grass Tissue Analytical Results (Wet Weight and Dry Weight Basis): Baseline Ecological Risk Assessment Field Investigation
- 4-45 SWMU 2 Co-Located Open Water Sediment Analytical Results: Baseline Ecological Risk Assessment Field Investigation
- 4-46 Open Water Reference Area No. 2 Co-Located Sediment Analytical Results: Baseline Ecological Risk Assessment Field Investigation
- 4-47 Maximum Hazard Quotient Values for West Indian Manatee Dietary Exposures to Ecological Chemicals of Concern in SWMU 2 Open Water Sediment

LIST OF FIGURES

- 1-1 Navy Ecological Risk Assessment Tiered Approach

- 2-1 Regional Location Map
- 2-2 SWMU/AOC Location Map
- 2-3 Terrestrial and Aquatic Habitat Occurring at Naval Activity Puerto Rico
- 2-4 Approximate Location of *Cobana negra*
- 2-5 Wetland Location Map
- 2-6 The Cowardin Wetland Classification System
- 2-7 Historical Manatee Sightings in Eastern Puerto Rico
- 2-8 Sea Turtle Sightings at Naval Activity Puerto Rico
- 2-9 Potential Turtle Nesting Sites
- 2-10 Soil, Surface Water, and Sediment Sampling Locations for Analytical Data used in the SERA and Step 3A of the BERA
- 2-11 Concentrations of Ecological Chemicals of Concern in Surface Soil Exceeding Soil Screening Values: SERA and Step 3a of the BERA
- 2-12 Concentrations of Ecological Chemicals of Concern in Subsurface Soil Exceeding Soil Screening Values: SERA and Step 3a of the BERA
- 2-13 Concentrations of Ecological Chemicals of Concern in Estuarine Wetland Sediment Exceeding Sediment Screening Values: SERA and Step 3a of the BERA
- 2-14 Refined Conceptual Model

- 3-1 Upland, Estuarine Wetland, and Open Water Reference Areas
- 3-2 SWMU 2 and Upland Reference Area Soil Sampling Locations: Verification of the Field Sampling Design
- 3-3 SWMU 2 and Estuarine Wetland Reference Area Sediment Sampling Locations: Verification of the Field Sampling Design
- 3-4 Open Water Reference Area No. 1 Sediment Sampling Locations: Verification of the Field Sampling Design
- 3-5 Open Water Reference Areas Nos. 2 and 3 Sediment Sampling Locations: Verification of the Field Sampling Design
- 3-6 SWMU 2 and Upland Reference Area No. 2 Soil Sample Locations: Baseline Ecological Risk Assessment Field Investigation
- 3-7 Upland Reference Area No. 2 Soil Sampling Locations: Baseline Ecological Risk Assessment Field Investigation
- 3-8 SWMU 2 Estuarine Wetland Sediment Sampling Grids: Baseline Ecological Risk Assessment Field Investigation
- 3-9 SWMU 2 Estuarine Wetland Sediment Sampling Locations: Baseline Ecological Risk Assessment Field Investigation
- 3-10 Estuarine Wetland Reference Area Sediment Sampling Locations: Baseline Ecological Risk Assessment Field Investigation
- 3-11 SWMU 2 Estuarine Wetland Fiddler Crab Tissue Sampling Locations: Baseline Ecological Risk Assessment Field Investigation
- 3-12 SWMU 2 Open Water Turtle Grass Tissue and Co-Located Sediment Sampling Locations: Baseline Ecological Risk Assessment Field Investigation
- 3-13 Open Water Reference Area No. 2 Turtle Grass Tissue and Co-Located Sediment Sampling Locations: Baseline Ecological Risk Assessment Field Investigation

LIST OF APPENDICES

Appendix A	Habitat Characterization of Solid Waste Management Units (SWMU) 1, SWMU 2, and SWMU 45
Appendix B	Toxicity Testing Laboratory Scope of Work 28-Day <i>Eisenia fetida</i> Survival, Growth, and Reproduction Tests 28-Day <i>Leptocheirus plumulosus</i> Survival, Growth, and Reproduction Tests 20-Day <i>Neanthes arenaceodentata</i> Survival and Growth Tests
Appendix C	Field Notes
Appendix D	Chain-of-Custody Forms Verification of the Field Sampling Design BERA Field Investigation
Appendix E	<i>Eisenia fetida</i> , <i>Leptocheirus plumulosus</i> , and <i>Neanthes arenaceodentata</i> Toxicity Test Report
Appendix F	Data Validation Narratives Severn Trent – Savannah SDG SWMU24740-1 Severn Trent – Savannah SDG SWMU24740-2/SWMU24740-3 Severn Trent – Savannah SDG PRN20478 Severn Trent – Pittsburgh SDG C7E0220126 Severn Trent – Seattle SDG 580-5970-1 Severn Trent – Savannah SDG SWMU26880-1 Severn Trent – Savannah SDG SWMU26880-2 Severn Trent – Savannah SDG SWMU27044 Severn Trent – Savannah SDG SWMU26980 Severn Trent – Savannah SDG SWMU28224-1 Severn Trent – Savannah SDG 680-23902-1 Severn Trent – Savannah SDG 680-23974-1
Appendix G	95 Percent UCL of the Mean Ecological COC Concentrations in SWMU 2 Soil
Appendix H	Regression Reports for <i>Eisenia fetida</i> Survival and Growth Data Pair-Wise Linear Regression Reports All Possible Regression Multiple Regression Reports
Appendix I	95 Percent UCL of the Mean Ecological COC Concentrations in SWMU 2 Earthworm Tissue
Appendix J	95 Percent UCL of the Mean Ecological COC Concentrations in SWMU 2 Estuarine Wetland Sediment
Appendix K	Regression Reports for <i>Leptocheirus plumulosus</i> Survival and Growth Data Pair-wise Linear Regression Reports All Possible Regression and Multiple Regression Reports
Appendix L	Regression Reports for <i>Neanthes arenaceodentata</i> Survival Data Pair-Wise Linear Regression Reports All Possible Regression and Multiple Regression Reports
Appendix M	95 Percent UCL of the Mean Ecological COC Concentrations in SWMU 2 Fiddler Crab Tissue

LIST OF ACRONYMS AND ABBREVIATIONS

α	Type I Error Rate
AET	Apparent Effects Threshold
ANOVA	Analysis of Variance
As	Arsenic
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	Area Use Factor
AVS	Acid Volatile Sulfide
Baker	Baker Environmental, Inc.
BERA	Baseline Ecological Risk Assessment
BW	Body Weight
BW _r	Body Weight of Receptor Species
BW _t	Body Weight of Test Species
CAO	Corrective Action Objective
CEC	Cation Exchange Capacity
CEPA	California Environmental Protection Agency
Cd	Cadmium
cf	cubic foot
CMS	Corrective Measures Study
CNO	Chief of Naval Operations
COC	Chemical of Concern
CRDL	Contract Required Detection Limit
CTO	Contract Task Order
Cu	Copper
DCQAP	Data Collection Quality Assurance Plan
DDD	1,1-dichloro-2,2-bis(<i>p</i> -chlorophenyl)ethylene
DDT	1,1,1-trichloro-2,2-bis(<i>p</i> -chlorophenyl)ethane
DI _x	Dietary intake for chemical x
DoN	Department of the Navy
DMP	Data Management Plan
DQO	Data Quality Objective
E2SS3	Estuarine, Intertidal, Scrub-Shrub, Broad-Leaved Evergreen
E2US2	Estuarine, Intertidal, Unconsolidated Shore, Sand
E2US3	Estuarine, Intertidal, Unconsolidated Shore, Mud
E2US4	Estuarine, Intertidal, Unconsolidated Shore, Organic
EA	Environmental Assessment
Eh	Oxidation-Reduction Potential
ERA	Ecological Risk Assessment
ER-L	Effects Range-Low
ER-M	Effects Range-Median
FC _{xi}	Maximum concentration of chemical x in food item i
FIR	Food Ingestion Rate
FSAP	Field Sampling and Analysis Plan

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

GPS	Global Positioning System
HASP	Health and Safety Plan
Hg	Mercury
HQ	Hazard Quotient
HWM	High Molecular Weight
IAS	Initial Assessment Study
ICM	Interim Corrective Measure
J	validation code (the analyte was positively detected; however, the concentration value is an estimate)
kg	kilogram
kg/day	kilogram per day
km	kilometer
LEL	Lowest Effects Level
LMW	Low Molecular Weight
LOAEL	Lowest Observed Adverse Effects Level
MATC	Maximum Acceptable Toxicant Concentration
MDL	Method Detection Limit
MeHg	Methylmercury
MeSe	Methylselenium
mg/kg	milligram per kilogram
mg/kg-BW/day	milligram per kilogram body weight per day
MHSPE	Ministry of Housing, Spatial Planning, and Environment
MRL	Method Reporting Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAPR	Naval Activity Puerto Rico
ND	Not Detected
NEESA	Naval Energy and Environmental Support Activity
NFESC	Naval Facilities Engineering Service Center
NSRR	Naval Station Roosevelt Roads
NAVFAC	Naval Facilities Engineering Command
NOAEL	No Observed Adverse Effect Level
NOAEL _r	No Observed Adverse Effect Level of the receptor species
NOAEL _t	No Observed Adverse Effect Level of the test species
p	Probability Level
PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead
PDF _i	Proportion of diet composed of food item i
PDS	proportion of diet composed of soil or sediment
PEL	Probable Effects Level

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PMP	Project Management Plan
ppt	parts per thousand
PRDNR	Puerto Rico Department of Natural Resources
QA/QC	Quality Assurance/Quality Control
R	Correlation Coefficient
r^2	Coefficient of Determination
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RPD	Relative Percent Difference
Sb	Antimony
SC _x	Maximum concentration of chemical x in sediment
SDG	Sample Delivery Group
Se	Selenium
SEM	Simultaneously Extracted Metals
SERA	Screening-Level Ecological Risk Assessment
SI	Supplemental Investigation
SOP	Standard Operating Procedure
SOW	Scope of Work
SSL	Soil Screening Level
STL	Sevren Trent Laboratories
SWMU	Solid Waste Management Unit
TEL	Threshold Effects Level
TOC	Total Organic Carbon
TRV	Toxicity Reference Value
U	validation code (the analyte was analyzed for, but not detected at the reported sample quantitation limit)
UCL	Upper Confidence Limit
µg/kg	microgram per kilogram
µm	micrometer
UJ	validation code (the analyte was analyzed for, but not detected above the reported sample quantitation limit; the reported sample quantitation limit is qualified as estimated)
ULM	Upper Limit of the Mean
µmole/gram	micromole per gram
UNEP	United Nations Environmental Program
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USEPA	United States Environmental Protection Agency
Zn	Zinc

EXECUTIVE SUMMARY

This document presents Step 5 (field verification), Step 6 (data analysis and evaluation), and Step 7 (risk characterization) of the baseline ecological risk assessment (BERA) for Solid Waste Management Unit (SWMU) 2 – Langley Drive Disposal Area, located at Naval Activity Puerto Rico (NAPR), formerly Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico. The BERA was performed in accordance with the procedures presented in the *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2* (Baker, 2007), and focused on those chemical-receptor-pathway combinations where unacceptable risk was indicated by Step 3a of the ERA process (Baker, 2006a). The general risk questions that focused the BERA for SWMU 2 are listed below.

- Are ecological chemicals of concern (COC) concentrations in SWMU 2 surface and subsurface soil high enough to impair the survival, growth, or reproduction of terrestrial invertebrate communities?
- Are ecological COC concentrations in SWMU 2 surface and subsurface soil high enough to impair the survival, growth, or reproduction of terrestrial avian omnivore populations?
- Are ecological COC concentrations in SWMU 2 estuarine wetland sediment high enough to impair the survival, growth, or reproduction of aquatic invertebrate communities?
- Are ecological COC concentrations in SWMU 2 estuarine wetland sediment high enough to impair the survival, growth, or reproduction of avian invertivore populations?
- Are ecological COC concentrations in SWMU 2 open water sediment (i.e., Ensenada Honda sediment) high enough to adversely affect the survival, growth, or reproduction of West Indian manatees?

The lines of evidence considered in the evaluation of these risk questions were:

Terrestrial invertebrates:

- Comparison of antimony, copper, lead, mercury, and zinc concentrations in SWMU 2 surface and subsurface soil with soil screening values and literature-based effect levels
- Comparison of results of 28-day laboratory toxicity tests (survival, growth, and reproduction) with the earthworm *Eisenia fetida*, using site and reference surface and subsurface soil
- Existence of significant correlations between laboratory toxicity test results and concentrations of antimony, copper, lead, mercury, and zinc in soil or other chemical/physical characteristics of the tested soil (e.g., total organic carbon [TOC], pH, and grain size distributions)

Terrestrial avian omnivores:

- Comparison of modeled dietary intakes of antimony, copper, lead, mercury, and zinc using measured tissue concentrations in earthworms maintained in site soil during toxicity testing with ingestion-based toxicity reference values (TRVs) (although antimony was not identified as an ecological COC in Step 3a of the BERA for terrestrial avian omnivore dietary exposures, this metal was included in the evaluation of this line of evidence since the

maximum detected concentration was measured in soil collected during the BERA field investigation)

Estuarine wetland benthic invertebrates:

- Comparisons of copper, lead, mercury, and zinc concentrations in sediment with sediment screening values (although mercury was not identified as an ecological COC in Step 3a of the BERA for benthic invertebrate communities, this metal was included in the evaluation of this line of evidence since the maximum detected concentration was measured in sediment collected during the BERA field investigation)
- Comparison of simultaneously extracted metals (SEM) sediment concentrations with acid volatile sulfide (AVS) sediment concentrations
- Comparison of results of 28-day sediment laboratory toxicity tests (survival, growth, and reproduction) with the burrowing amphipod *Leptocheirus plumulosus* and 20-day sediment laboratory toxicity tests (survival and growth) with the polychaete *Neanthes arenaceodentata*, using site and reference sediment
- Existence of significant correlations between laboratory toxicity test results and concentrations of copper, lead, mercury and zinc in sediment or other chemical/physical characteristics of the tested sediment (e.g., SEM-to-AVS ratio, TOC, pH, and grain size distributions), sediment pore water, and overlying water.

Estuarine wetland avian invertivores:

- Comparison of modeled dietary intakes of lead and mercury using measured tissue concentrations in fiddler crabs (*Uca* spp.) collected from the estuarine wetland habitat at SWMU 2 with ingestion-based TRVs.

West Indian manatees:

- Comparison of modeled dietary intakes of arsenic, cadmium, copper, lead, mercury, selenium, and zinc using measured tissue concentrations in turtle grass collected from the open water habitat at SWMU 2 with ingestion-based TRVs.

Conclusions from the evaluation of each receptor/receptor group, as well as recommendations for the SWMU are presented below.

Terrestrial Invertebrate Communities

The available soil analytical data for SWMU 2 (i.e., one surface soil and seven subsurface soil samples collected during a Supplemental Investigation [SI] conducted in 1992, eleven surface soil samples collected during a Resource Conservation and Recovery Act [RCRA] Facility Investigation [RFI] conducted in 1996, twelve surface soil and five subsurface soil samples collected during an additional data collection investigation conducted in 2004, and fifty surface soil and eight subsurface soil samples collected during the BERA field investigation) were combined into a unified data set and used to derive risk estimates (i.e., hazard quotient [HQ] values) for terrestrial invertebrate direct contact exposures. HQ values were derived using maximum, 95 percent upper confidence (UCL) of the mean, and arithmetic mean antimony, copper, lead, mercury, and zinc concentrations:

Ecological COC	Maximum HQ	95 Percent UCL of the Mean HQ	Arithmetic Mean HQ
Antimony	0.46	0.08	0.03
Copper	241.25	19.33	6.85
Lead	3.44	0.30	0.21
Mercury	190.00	15.13	5.41
Zinc	105.83	13.05	5.02

The comparison of antimony, copper, lead, mercury, and zinc concentrations in SWMU 2 soil to soil screening values indicated that antimony and lead present minimal risks to terrestrial invertebrate communities. HQ values based on 95 percent UCL of the mean concentrations are 0.08 for antimony and 0.30 for lead). However, 95 percent UCL of the mean HQ values for copper, mercury, and zinc (19.33, 15.13, and 13.05, respectively) indicate that these three metals may be impacting terrestrial invertebrate communities at SWMU 2.

Twelve SWMU 2 and three reference area soil samples collected during the BERA field investigation were tested for toxicity using *Eisenia fetida* to further refine potential risks suggested by the comparison of ecological COC concentrations to soil screening values. Toxicity tests also were conducted since they can account for effects of multiple chemicals (i.e., additive, synergistic, and antagonistic effects), as well as site-specific factors that may influence the bioavailability of metals (e.g., pH, TOC, and grain size characteristics). The SWMU 2 soil samples selected for earthworm toxicity testing exhibited a range of ecological COC concentrations, from non-detected values or values below soil screening values to maximum detected concentrations. Test endpoints for *Eisenia fetida* were survival, calculated as the percentage of test organisms at test initiation that survived in each replicate at test termination, growth, calculated as weight loss per surviving earthworm in each replicate at test termination, and reproduction, expressed as the number of juveniles and cocoons per surviving earthworm in each replicate at test termination.

The survival, growth (i.e. weight loss), and reproduction data were subjected to hypothesis testing to determine if measured biological responses in SWMU 2 and reference area soil are equal. Statistical evaluations performed by the testing laboratory indicated that earthworm reproduction (juvenile and cocoon production per surviving earthworm) in SWMU 2 soil was not significantly lower than reproduction in each reference area soil sample. A significant response was detected by the statistical tests evaluating earthworm survival and growth. However, a clear dose-response relationship could not be established for any of the ecological COCs. Therefore, it was concluded that physical and/or chemical parameters other than ecological COC concentrations were responsible for or influencing the observed biological responses.

Pair-wise linear regressions and multiple regressions were run to further examine the relationship between earthworm survival and weight loss and the chemical/physical characteristics of SWMU 2 soil. The pair-wise linear regressions indicated that antimony had a significant influence on earthworm survival (earthworm survival decreased as the antimony concentration increased). None of the ecological COCs had a significant influence on earthworm weight loss. It is noted that an evaluation of the linear regression scatter plot for antimony does not indicate that a dose-response relationship exists between earthworm survival and antimony soil concentrations.

To further evaluate the relationship between TOC, pH, and ecological COC concentrations in surface soil and earthworm responses in the toxicity tests (survival and weight loss), a multiple regression

analysis was performed using NCSS software. Prior to the analysis, the All Possible Regression variable selection routine was run to identify appropriate models to include within the multiple regression analyses. A five variable model was selected for the survival endpoint (antimony, soil pH at test initiation, percent gravel, percent sand, and percent fines). A five variable model was selected for the growth endpoint (copper, mercury, lead, TOC, and percent gravel). Multiple regression analysis indicated that both models are significant. Independent variables within each model also were found to have a significant influence on survival (antimony, percent gravel, percent sand, and percent fines) and weight loss (copper and percent gravel). The lack of a dose response in the toxicity test data paired with the significant pair-wise and multiple regression results suggest that the bioavailability and toxicity of the ecological COCs are being influenced by physical characteristics of the soil (i.e., grain size characteristics). However, these modifying factors, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured soil trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in soil and earthworm responses in the toxicity tests.

In summary, the three lines of evidence used to evaluate terrestrial invertebrate direct contact exposures to ecological COCs in SWMU 2 soil support a conclusion of unacceptable risk. However, clear relationships between ecological COC concentrations in soil and earthworm responses in the toxicity tests could not be established.

Terrestrial Avian Omnivore Populations

A single line of evidence was used to evaluate potential risks to terrestrial avian omnivores from dietary exposures to antimony, copper, lead, mercury, and zinc in SWMU 2 soil. The American robin was used as a representative species for terrestrial avian omnivores at SWMU 2, including the endangered yellow-shouldered blackbird. Dietary intakes were estimated using (1) 95 percent UCL of the mean soil concentrations for a combined surface and subsurface soil data set consisting of analytical data from the 1992 SI, 1996 RFI, 2004 additional data collection investigation, and BERA field investigation data set, and (2) 95 percent UCL of the mean tissue data from earthworms maintained in surface soil during toxicity testing. Ingestion-based risk estimates (i.e., HQ values) for the American robin were calculated by dividing dietary intakes by literature-based no observed adverse effect level (NOAEL) values (because the American robin was used as a surrogate receptor for the yellow-shouldered blackbird, conclusions regarding the acceptability of risk are based solely on NOAEL-based risk estimates):

Ecological COC	95 Percent UCL of the Mean NOAEL-Based HQ Value (SWMU 2)
Antimony	<0.01
Copper	2.74
Lead	2.10
Mercury	2.10
Zinc	0.26

As evidenced by the table above, copper, lead, and mercury NOAEL-based HQ values using 95 percent UCL of the mean soil and earthworm tissue concentrations are greater than 1.0. The HQ values indicate that these six chemicals are bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations that feed exclusively on terrestrial invertebrates within the upland areas at SWMU 2. NOAEL-based risk estimates for American robin dietary exposures to antimony and zinc in SWMU 2 surface soil are less than 1.0 (<0.01 and 0.26,

respectively). The HQ values for antimony and zinc indicate that these two metals are not bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations feeding exclusively on terrestrial invertebrates at SWMU 2.

To determine if potential risks presented by copper, lead, and mercury to terrestrial avian omnivore populations at SWMU 2 are site-related, risk estimates also were derived for American robin dietary exposures to these three metals in Upland Reference Area No. 2 soil. Based on the low number of upland reference area earthworm tissue samples submitted for analytical testing (three earthworm tissue samples), 95 percent UCL of mean earthworm tissue concentrations could not be calculated. Therefore, upland reference area risk estimates were derived using maximum surface soil and earthworm tissue concentrations. Maximum NOAEL-based HQ values for American robin dietary exposures at Reference Area No. 2 are summarized in the table below.

Ecological COC	Maximum NOAEL-Based HQ Value (Reference Area)
Copper	0.39
Lead	0.21
Mercury	0.23

As evidenced by the table, NOAEL-based HQ values for each metal, derived using maximum soil and earthworm tissue concentration, are less than 1.0, indicating that potential risks presented by copper, lead, and mercury in SWMU 2 soil are site-related. In summary, the single line of evidence used to evaluate terrestrial avian omnivores supports a conclusion of unacceptable risk from dietary exposures to copper, lead, and mercury in SWMU 2 soil.

Estuarine Wetland Invertebrate Communities

The available estuarine wetland sediment analytical data for SWMU 2 (i.e., nine sediment samples collected during the 1996 RFI, ten sediment samples collected during the 2004 additional data collection investigation, and twenty-three sediment samples collected during the BERA field investigation) were combined into a unified data set and used to derive risk estimates (i.e., HQ values) for terrestrial invertebrate direct contact exposures. HQ values were derived using maximum, 95 percent upper confidence (UCL) of the mean, and arithmetic mean antimony, copper, lead, mercury, and zinc concentrations:

Ecological COC	Maximum HQ	95 Percent UCL of the Mean HQ	Arithmetic Mean HQ
Copper	37.97	7.49	5.79
Lead	14.90	3.21	1.70
Mercury	10.00	2.02	1.32
Zinc	3.39	0.89	0.66

The comparison of copper, lead, mercury, and zinc concentrations in SWMU 2 estuarine wetland sediment indicated that zinc presents minimal risk to benthic invertebrate communities (95 percent UCL of the mean HQ of 0.89). However, 95 percent UCL of the mean HQ values for copper, lead, and mercury (7.49, 3.21, and 2.02, respectively) indicate that these three metals may be impacting benthic invertebrate communities within the estuarine wetland downgradient from at SWMU 2.

Total metals concentrations in sediment are poor predictors of toxicity due to a number of modifying factors, including pH, TOC, grain size characteristics, and AVS (Ankley et al., 1996, John and Leventhal, 1985, Luoma, 1983, NFESC, 2000, Pereira et al., 2008, Warren et al., 1994, and Wood

and Shelley, 1999). The bioavailability of copper, lead, mercury, and zinc were further evaluated by (1) comparison of SEM sediment concentrations to AVS sediment concentrations, (2) comparison of SWMU 2 and reference area *Leptocheirus plumulosus* (amphipod) and *Neanthes Arenaceodentata* (polychaete) toxicity test results, and/or (3) evidence of a significant correlation between amphipod and polychaete toxicity test results and the chemical/physical characteristics of sediment, pore water, and overlying water for those endpoints in which a overall significant negative result was measured.

A total of eight SWMU 2 and two estuarine wetland reference area sediment samples were submitted for toxicity testing and AVS/SEM analyses. The molar concentration of SEM metals (cadmium, copper, lead, nickel, silver, and zinc) in four sediment samples (2B-EWSD09, 2B-EWSD15, 2B-EWSD18, and 2B-EWSD20) exceeded the molar concentration of AVS (i.e., SEM-to-AVS ratios greater than 1.0), indicating that sediment-associated biota may be exposed to toxic concentrations of SEM metals in the sediment pore water:

Sample Identification	SEM (μmole/g)	AVS (μmole/g)	SEM-to-AVS Ratio
2B-EWSD04	0.3275	1.1541	0.28
2B-EWSD09	9.0536	0.0561	161.38
2B-EWSD12	0.5160	2.7137	0.19
2B-EWSD15	5.6239	1.2477	4.51
2B-EWSD16	2.5684	0.0468	54.88
2B-EWSD18	3.3511	11.5409	0.29
2B-EWSD20	1.1984	5.3026	0.23
2B-EWSD24	2.4162	0.0530	45.59

As indicated above, eight SWMU 2 and two reference area sediment samples collected during the BERA field investigation were tested for toxicity using *Leptocheirus plumulosus* and *Neanthes Arenaceodentata* (polychaete) to further refine potential risks suggested by the comparison of ecological COC concentrations to sediment screening values and the comparison of SEM molar concentrations to AVS molar concentrations. Sediment toxicity tests were conducted since they can account for effects of multiple chemicals (i.e., additive, synergistic, and antagonistic effects), as well as site-specific factors that may influence the bioavailability of metals (e.g., pH, TOC, AVS, and grain size characteristics). The SWMU 2 sediment samples selected for amphipod and polychaete toxicity testing exhibited a range of ecological COC concentrations, from non-detected values or values below sediment screening values to maximum detected concentrations.

Test endpoints for *Leptocheirus plumulosus* were survival, calculated as the percentage of test organisms at test initiation that survived in each replicate at test termination, growth, calculated as dry weight per surviving adult amphipod at test termination, and reproduction, calculated as juvenile production per surviving adult amphipod at test termination. Test endpoints for *Neanthes Arenaceodentata* were survival, calculated as the percentage of test organisms at test initiation that survived at test termination, and growth, calculated as mean dry weight per surviving polychaete at test termination. The amphipod survival, growth, and reproduction data and polychaete survival and growth data were subjected to hypothesis testing to determine if measured biological responses in SWMU 2 and reference area sediment samples are equal. Statistical evaluations performed by the testing laboratory indicated amphipod reproduction and polychaete growth in SWMU 2 sediment was not significantly lower than amphipod reproduction and polychaete growth in each reference area sediment sample. A significant response was detected by the statistical tests evaluating amphipod survival and growth and polychaete survival. However, a clear dose-response relationship could not be established for any of the ecological COCs. Therefore, it was concluded that physical and/or

chemical parameters other than ecological COC concentrations were responsible for or influencing the observed biological responses.

Pair-wise linear regressions and multiple regressions were run to further examine the relationship between amphipod survival and growth, polychaete survival, and the chemical/physical characteristics of SWMU 2 sediment. The pair-wise linear regressions performed on the amphipod toxicity test data indicated that none of the ecological COCs had a significant influence on survival and growth. However, sediment pH and overlying water pH, total ammonia, and salinity had a significant influence of survival. Sediment pH and overlying water pH and total ammonia also had a significant influence on amphipod growth. The linear regression reports for these variables showed the following relationships:

- Amphipod survival and growth decreased as sediment pH increased
- Amphipod survival and growth decreased as overlying water pH increased
- Amphipod survival and growth increased as overlying water total ammonia increased
- Amphipod survival increased as overlying water salinity increased

The pair-wise linear regressions performed on the polychaete toxicity test data also indicated that none of the ecological COCs had a significant influence on polychaete survival. However, SEM-to-AVS ratios and the percent sand content of sediment had a significant influence on polychaete survival. The linear regression reports for these two variables showed the following relationships:

- Polychaete survival decreased as SEM-to-AVS ratio increased
- Polychaete survival decreased as the percent sand content of sediment increased

To further evaluate the relationship between copper, lead, mercury, and zinc concentrations in sediment, sediment pH, overlying water pH, salinity, and total ammonia, and amphipod survival in the toxicity tests, a multiple regression analysis was performed. A multiple regression analysis also was performed to further evaluate the relationship between copper, lead, mercury, and zinc concentrations in sediment, SEM-to-AVS ratio, and percent sand. Prior to the analysis, the All Possible Regression variable selection routine was run to identify appropriate models to include within the multiple regression analysis. A three variable model was selected for the amphipod survival endpoint (copper, lead, and sediment pH), while a four variable model was selected for the polychaete survival endpoint (copper, lead, SEM-to-AVS ratio, and percent sand). It is noted that a multiple regression analysis could not be performed on the amphipod growth endpoint due to zero percent survival in four sediment samples and insufficient biomass in a fifth sediment sample. Multiple regression analysis indicated that both models were significant. Independent variables within each model also were found to have a significant influence on amphipod survival (copper and sediment pH) and polychaete survival (SEM-to-AVS ratio). The lack of a dose response in the toxicity test data paired with the significant pair-wise and multiple regression results suggest that the bioavailability and toxicity of the ecological COCs are being influenced by physical/chemical characteristics of the sediment (i.e., sediment pH and AVS concentration). However, these modifying factors, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured soil trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in soil and earthworm responses in the toxicity tests.

In summary, the lines of evidence used to evaluate benthic invertebrate direct contact exposures to ecological COCs in SWMU 2 sediment support a conclusion of unacceptable risk. However, clear relationships between ecological COC concentrations in sediment and amphipod survival and growth and polychaete survival cannot be established.

Estuarine Wetland Avian Invertivore Populations

A single line of evidence was used to evaluate potential risks to avian invertivores from dietary exposures to lead and mercury in estuarine wetland sediment. The spotted sandpiper was used as a representative species for avian invertivores at SWMU 2. Dietary intakes were estimated using (1) 95 percent UCL of the mean sediment concentrations for a combined sediment data set consisting of analytical data from the 1996 RFI, 2004 additional data collection investigation, and BERA field investigation, and (2) 95 percent UCL of the mean tissue data from field collected fiddler crabs. Ingestion-based risk estimates (i.e., HQ values) for the spotted sandpiper were calculated by dividing dietary intakes by literature-based maximum acceptable toxicant concentration (MATC) values:

Ecological COC	95 Percent UCL of the Mean MATC-Based HQ Value (SWMU 2)
Lead	2.60
Mercury	0.84

Based on the MATC HQ values summarized above, it was concluded that lead is bioaccumulating within invertebrate tissue at concentrations that could impact avian invertivore populations that feed exclusively on benthic invertebrates within the estuarine wetland habitat at SWMU 2. In the case of mercury, a MATC-based HQ value less than 1.0 indicates that this metal is not bioaccumulating within invertebrate tissue at concentrations that would impact avian invertivore populations. To determine if potential risks presented by lead to avian invertivore populations at SWMU 2 are site-related, risk estimates also were derived for spotted sandpiper dietary exposures to this metal at the estuarine wetland reference area. Based on the low number of tissue and sediment samples collected at the estuarine wetland reference area during the BERA field investigation (four tissue samples and six sediment samples), 95 percent UCL of mean tissue and sediment concentrations were not calculated. Instead, estuarine wetland reference area risk estimates for lead were derived using maximum sediment and fiddler crab tissue concentrations

The maximum MATC-based HQ value for spotted sandpiper dietary exposures at the estuarine wetland reference area is 0.22. This value clearly shows that potential risks presented by lead to avian invertivore populations at SWMU 2 are site-related. In summary, the single line of evidence used to evaluate avian invertivores supports a conclusion of unacceptable risk from dietary exposures to lead in SWMU 2 estuarine wetland sediment.

West Indian Manatees

Identical to the evaluation of terrestrial avian omnivores and estuarine wetland avian invertivores, a single line of evidence was used to evaluate potential risks to West Indian manatees that may forage within the open water portion of SWMU 2: comparison of estimated arsenic, cadmium, copper, lead, mercury, selenium, and zinc dietary intakes using maximum sediment and turtle grass tissue concentrations to NOAEL-based screening values. As evidenced by the table below, maximum HQ values for arsenic, cadmium, copper, lead, mercury, selenium, and zinc are less than 1.0, indicating

that these six metals are not bioaccumulating in turtle grass at concentrations that would impact West Indian manatees feeding exclusively within the open water portion of SWMU 2.

Ecological COC	NOAEL-Based HQ Value (SWMU 2)
Arsenic	0.65
Cadmium	0.12
Copper	0.20
Lead	0.09
Mercury	0.64
Selenium	0.79
Zinc	0.63

Because the evaluation did not detect any unacceptable risks to West Indian manatees feeding exclusively at SWMU 2, risk estimates for West Indian manatees feeding exclusively at the open water reference area were not derived.

Recommendations

The lines of evidence for terrestrial invertebrates, terrestrial avian omnivores, estuarine wetland benthic invertebrates, and estuarine wetland avian invertivores, when evaluated using a weight-of-evidence approach and taking into consideration the uncertainty associated with them (see Section 7.0), support additional evaluation. Initially, it is recommended that an Interim Corrective Measure (ICM) be performed (i.e., soil removal) to eliminate potential risks to terrestrial avian omnivores from exposures to copper, lead, and mercury in soil (surface and subsurface soil). The ICM also will serve to reduce potential risks presented by antimony, copper, lead, mercury, and zinc to terrestrial invertebrates based on their co-location with one another. Finally, the ICM will serve to eliminate/reduce potential source areas in upland habitat serving as a release point for chemical migration to the estuarine wetland. Specifics of the soil removal action, including locations and volumes, will be detailed within the ICM's Basis of Design Report. Following the ICM, it is recommended that SWMU 2 proceed to a CMS to further address low-level, wide-spread spatial coverage of ecological COCs above soil and background soil screening values, as well as unacceptable risks presented by copper, lead, mercury, and zinc to estuarine wetland benthic invertebrates and/or avian invertivores. Based on the evaluation of West Indian manatee dietary exposures using measured ecological COC concentrations in turtle grass tissue and sediment, a recommendation of corrective action complete without controls is made for sediments within the Ensenada Honda.

1.0 INTRODUCTION

This document presents Step 5 (field verification), Step 6 (data analysis and evaluation), and Step 7 (risk characterization) of the baseline ecological risk assessment (BERA) for Solid Waste Management Unit (SWMU) 2 – Langley Drive Disposal Area, located at Naval Activity Puerto Rico (NAPR), formerly Naval Station Roosevelt Roads (NSRR), Ceiba, Puerto Rico. This report has been prepared by Baker Environmental, Inc. (Baker) under contract to the Atlantic Division, Naval Facilities Engineering Command (NAVFAC Atlantic), Contract Number N62470-02-D-3052, Contract Task Order (CTO) 0108 and conforms to the provisions of the Resource Conservation and Recovery Act (RCRA) 7003 Administrative Order on Consent (United States Environmental Protection Agency [USEPA] Docket No. RCRA-02-2007-7301).

The BERA at SWMU 2 was performed in accordance with Navy policy for conducting ecological risk assessments (ERAs) (Chief of Naval Operations [CNO], 1999) and the Navy guidance for conducting ERAs (available at <http://web.ead.anl.gov/ecorisk/>), as well as guidance provided by the USEPA (1997a). The Navy ERA process (see Figure 1-1) consists of eight steps organized into three tiers and represents a clarification and interpretation of the eight-step ERA process outlined in the USEPA ERA guidance for the Superfund program (USEPA, 1997a). Tier 1 of the Navy ERA process represents the screening-level ecological risk assessment (SERA), which consists of the following steps:

- Step 1 – Screening-Level Problem Formulation
- Step 2 – Screening-Level Exposure Estimate and Risk Calculation

The BERA represents Tier 2 of the Navy ERA process, which consists of the following steps:

- Step 3 – Baseline Problem Formulation
- Step 4 – Study Design/Data Quality Objectives (DQOs)
- Step 5 – Verification of Field Sampling Design
- Step 6 – Site Investigation and Data Analysis
- Step 7 – Risk Characterization

Under Navy policy and guidance, Step 3 is divided into two activities (i.e., Steps 3a and 3b). In Step 3a, the conservative exposure assumptions applied in the SERA are refined and risk estimates are recalculated using the same preliminary conceptual model developed in Step 1. The evaluation of risks in Step 3a may also include consideration of background data and chemical bioavailability. Step 3b (Baseline Problem Formulation) involves an evaluation of the toxicity of site-related chemicals, as well as the refinement of the preliminary conceptual model and assessment endpoints. Step 4 involves the development of measurement endpoints, the study design, and DQOs for the BERA, which may be adjusted based on verification of the field sampling design (Step 5).

Steps 1, 2, and 3a of the Navy ERA process were previously presented in the document entitled *Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2* (Baker, 2006a). Based on the determination of potential unacceptable risks to terrestrial plants and/or invertebrates (from exposures

to antimony, copper, lead, mercury, and zinc in surface and subsurface soil), terrestrial avian omnivores and herbivores (from food web exposures to lead, mercury, and zinc in surface soil and copper, lead, and zinc in subsurface soil), benthic invertebrates (from exposures to copper, lead, and zinc in estuarine wetland sediment), aquatic avian invertivores (from food web exposures to lead and mercury in estuarine wetland sediment), and the West Indian manatee (from food web exposures to arsenic, cadmium, copper, lead, mercury, selenium, and zinc in Ensenada Honda sediment), Step 3a included a recommendation that SWMU 2 be carried into Step 3b of the Navy ERA process. In response to this recommendation, Steps 3b and 4 of the Navy ERA process were conducted and presented in the document entitled *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2* (Baker, 2007).

This report reiterates Steps 1 through 4 of the Navy ERA process at SWMU 2 when appropriate to provide clarity and presents Step 5 (Verification of Field Sampling Design; conducted after finalization of the Steps 3b and 4 document), Step 6 (Site Investigation and Data Analysis), and Step 7 (Risk Characterization) of the BERA. Step 6 includes both the site investigation and data analysis, in which information collected during the BERA field investigation is used to characterize exposures and ecological effects. Step 7 of the BERA characterizes potential ecological risks at the SWMU using a weight-of-evidence approach. This characterization is used to make one of the following two risk management decisions:

- 1) No further evaluation or action from an ecological perspective is warranted because the SWMU does not pose unacceptable risk.
- 2) The SWMU poses unacceptable ecological risks and additional evaluation in the form of corrective measure alternatives development and evaluation (Tier 3; Step 8) is appropriate.

The organization of this document is as follows:

- Section 1. Introduction – Summarizes the risk assessment process and report organization.
- Section 2. BERA Problem Formulation and Study Design/Data Quality Objectives – Provides a description of NAPR and SWMU 2 and reviews Steps 3b and 4 of the BERA.
- Section 3. BERA Field Investigation Summary – Reviews the various field and laboratory investigation activities that were implemented in conjunction with Steps 5 and 6 of the BERA.
- Section 4. Analytical Results and Data Analysis – Presents the analytical data for biotic and abiotic media collected during field investigation activities and provides an analysis of these data.
- Section 5. Risk Characterization – Characterizes risks to ecological receptors from exposures to ecological chemicals of concern (COCs) identified in Step 3a of the BERA using a weight-of-evidence approach.
- Section 6. Conclusions and Recommendations.
- Section 7. Uncertainties.
- Section 8. References

Supporting documentation, including field notes and data validation summary reports, is provided within Appendices.

2.0 BERA PROBLEM FORMULATION AND STUDY DESIGN

Step 3b of the Navy ERA process represents the BERA problem formulation, while Step 4 establishes the measurement endpoints, study design, and DQOs for the site investigations necessary to complete the ERA. The SWMU background (i.e., description, history, and environmental setting) is presented, ecological COCs are identified, the toxicity of each COC is evaluated, the site conceptual model is described, the assessment and measurement endpoints are identified, and the BERA study design is outlined. Steps 3b and 4 were originally presented in the document entitled *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico* (Baker, 2007). The main components of these steps are summarized in this section.

2.1 SWMU 2 Description

NAPR occupies over 8,600 acres on the northern side of the east coast of Puerto Rico along Vieques Passage (see Figure 2-1), with Vieques Island lying to the east about 10 miles off the harbor entrance. NAPR also occupies the immediately adjacent islands of Piñeros and Cabeza de Perro, as presented on Figure 2-2. The north entrance to NAPR is about 35 miles east along the coast road (Route 3) from San Juan. The closest large town is Fajardo (population approximately 41,000), which is located approximately 10 miles north of NAPR off Route 3. Ceiba (population approximately 18,000) adjoins the western boundary of NAPR (see Figure 2-1). NAPR was commissioned in 1943 as a Naval Operations Base. NAPR continued in this status until 1957 when it was redesignated a Naval Station (NSRR) with the mission of providing full support for Atlantic Fleet weapons training and development activities. NSRR operated as a Naval Station until March 31, 2004 at which time NSRR underwent operational closure. On April 1, 2004, NSRR was re-designated as NAPR. The current primary mission of NAPR is to protect the physical assets remaining, comply with environmental regulations, and sustain the value of the property until final disposition of the property.

SWMU 2, located approximately 1,000 feet northeast of the Navy Commissary [see Figure 2-2]), occupies an area of approximately 28 acres. The SWMU extends from Langley Drive into the Ensenada Honda (estimated length of 1,300 feet in a northeast-southwest direction) and is bounded by upland coastal forest and estuarine wetland communities to the north and south, the Ensenada Honda to the east, and Langley Drive to the west. Upland habitat, as well as estuarine wetland and open water habitat are included within the boundary of SWMU 2. Based on previous reports, the Langley Drive Disposal Area operated as a landfill from approximately 1939 to 1959 and is documented as having been used for the disposal of both hazardous and non-hazardous wastes (Naval Energy and Environmental Support Activity [NEESA], 1984). Debris noted during the Initial Assessment Study (IAS) included partially buried metal and concrete objects, old fuel lines, flexible metal hoses, sample containers containing pellets, steel cables, hardened tar, rubble, and ten to fifteen 55-gallon drums that were corroded. The drum contents, generally consisting of a whitish solid with a green outer crust, were exposed (NEESA, 1984). The IAS team estimated the volume of disposed waste to be approximately 1,700 cubic yards, of which approximately 20,000 pounds could be hazardous.

2.2 Environmental Setting

The sections that follow provide a description of the habitats and biota occurring at NAPR. The description of habitats and biota relies primarily on literature-based information for Puerto Rico and NAPR. This information is supplemented by site-specific observations recorded during the habitat characterization conducted within the upland and estuarine wetland habitats at SWMU 2 in May 2000 (the open water portion of the SWMU was not investigated). The habitat characterization report is included as Appendix A.

2.2.1 Terrestrial Habitats

The upland habitat bounded by NAPR is classified as subtropical dry forest (Ewel and Witmore, 1973). Similar to other forested areas of Puerto Rico, this region was previously clear-cut in the early part of the century, primarily for pastureland (Geo-Marine, Inc., 1998). After acquisition by the Navy, a secondary growth of thick scrub, dominated by lead tree (*Leucaena* spp.), Christmas tree (*Randia aculeata*), sweet acacia (*Acacia farnesiana*), and Australian corkwood (*Sesbania grandiflora*) grew in the previously grazed sections (Geo-Marine, Inc., 1998). Secondary growth communities (upland coastal forest communities and coastal scrub forest communities) exist today throughout the station's undeveloped upland.

The upland vegetative community within and contiguous to SWMU 2 is classified as an upland coastal forest community (see Figure 2-3). This community is limited to a shrub layer and herbaceous layer. The shrub layer is dominated by lead tree (*Leucaena leucocephala*), sweet acacia, and bottle wiss (*Capparis flexusa*), while the herbaceous layer is dominated by smut grass (*Sporobolus indicus*), guinea grass (*Panicum maximum*), cattle tongue (*Pluchea carolinensis*), and marsh mallow (*Waltheria indica*) (Geo-Marine, Inc., 2000). Maintained grasses, including yellow bluestem (*Bothriochloa ischaemum*), swollen fingergrass (*Chloris barbata*), and *Digitaria* spp., dominate areas immediately adjacent to road corridors.

Cobana negra (*Stahlia monosperma*), a federally threatened tree species, is known to occur between the boundary of black mangrove communities and coastal upland forest communities. This species is also known to occur in coastal forests of southeastern Puerto Rico (Little and Wadsworth, 1964). A single individual was encountered at NAPR during recent surveys conducted by Geo-Marine, Inc. (NAVFAC, 2006). This individual is located within a coastal scrub forest community near the Capehart housing area, west of American Circle, approximately 1.9 miles from SWMU 2 (see Figure 2-4). *Cobana negra* were not observed at SWMU 2 during the May 15 to May 19, 2000 habitat characterization. No other plant species listed under the provisions of the Endangered Species Act of 1973 are known to occur or have the potential to occur at NAPR (Geo-Marine, Inc., 2000 and NAVFAC, 2006).

2.2.2 Aquatic Habitats

Approximately 460 acres at NAPR are covered by palustrine habitat, which includes all freshwater wetlands. These wetlands include wet meadows and marshes, dominated by cattails (*Typha* spp.) and grasses (*Panicum* spp. and *Paspalum* spp.), as well as wet coastal scrub forests. The marine environment surrounding NAPR includes mudflats (approximately 161 acres), mangroves (approximately 2,700 acres) and seagrass beds (approximately 1,900 acres) (Geo-Marine, Inc., 1998). Coral reefs also are located in the offshore marine environment (see Figure 2-3). Coral reef types within the waters surrounding NAPR, as well as their associated acreage cover are provided within the table below (Department of the Navy [DoN], 2007).

Reef Habitat Type	Area (acres)
Colonized Bedrock	266
Linear reef	84
Patch Reef (Aggregated)	146
Patch reef (Individual)	175
Scattered Coral-Rock	5

As evidenced by Figure 2-3, coral reefs are not located within the open water portion of SWMU 2. The nearest reef habitat is located within the Ensenada Honda, immediately adjacent to the Deep Water Fueling Pier (approximately 0.95 miles from SWMU 2).

Mangroves at NAPR mainly consist of red mangrove (*Rhizophora mangle*), black mangrove (*Avicenia germinans*), and white mangrove (*Laguncularia racemosa*) (Geo-Marine, Inc., 2000 and 2005). Red mangroves tolerate relatively deep water levels, grow in unstable, soft soil, and tolerate a salinity range of 10 to 55 parts per thousand (ppt). They develop large prop roots which usually extend above the water surface. Black and white mangroves generally grow in areas that are not inundated by water. Mangroves at NAPR are natural filters for upland runoff and protect the coastline from storm damage (Lewis, 1986). They also provide habitat for wildlife, fish, and benthic invertebrates. Lewis (1986) reported 112 species of birds that use the NAPR mangroves as habitat for feeding, nesting, and roosting. The red mangrove prop root habitat in Puerto Rico also is used by at least 13 species of fish (including the gray snapper [*Lutjanus griseus*], lane snapper [*Lutjanus synagris*], and gold and black tricolor [*Holocanthus tricolor*]), several crustaceans (including the flat tree oyster [*Isognomon alatus*]), gastropods (including the coffee bean snail [*Melampus coffeus*] and mangrove periwinkle [*Littorina angulifera*]), echinoids (including the long-spined sea urchin [*Diadema antillarum*] and pencil sea urchin [*Eucidaris tribuloides*]), sponges (including the fire sponge [*Tedania ignis*]), ascidians (including the black tunicate [*Acsidia nigra*]), and hydroids (including the feathered hydroid [*Halocordyle disticha*]) (Geo-Marine, Inc., 2005).

The seagrass beds in eastern Puerto Rico are typical of well developed climax meadows found throughout the tropical Atlantic and Caribbean basin, consisting primarily of a dense, continuous coverage of turtle grass (*Thalassia testudinum*), with lesser amounts of manatee grass (*Syringodium filiforme*) and a wide diversity of calcareous algae (Reid et al., 2001). Patchy and sparse beds of mixed species, including shoal grass (*Halodule wrightii*), manatee grass, and paddle grass (*Halophila decipiens*), occur in localized areas affected and maintained by different wave regimes, substrate type, and turbidity than what is normally found in association with the climax turtle grass meadows.

The aquatic habitats occurring within and contiguous to SWMU 2 are depicted on Figures 2-3 and 2-5. As evidenced by both figures, an extensive estuarine wetland system is located within and contiguous to SWMU 2. The wetland units depicted on Figure 2-5, identified by the Cowardin Wetland Classification System (Cowardin et al., 1979; see Figure 2-6), were delineated by Geo-Marine, Inc. in December 1999 from 1993 color infrared and 1998 true color aerial photography. Twenty percent of the wetlands delineated by aerial photography were field checked by Geo-Marine, Inc. to verify the accuracy of the delineations. Field verification was based on the 1987 Corps of Engineers wetland delineation manual (United States Army Corps of Engineers [USACE], 1987). The estuarine wetland system within and contiguous to SWMU 2 includes both black and red mangrove communities. The red mangroves occur immediately adjacent to the Ensenada Honda (open water habitat), while black mangroves occur between the red mangroves and the upland coastal forest community. Specific wetland units located within the estuarine wetland system downgradient from SWMU 2 have the following Cowardin classifications: E2SS3 (Estuarine, Intertidal, Scrub-Shrub, Broad-Leaved Evergreen) and E2US2 (Estuarine, Intertidal, Unconsolidated Shore, Sand).

Seagrass beds are prevalent throughout much of the Ensenada Honda, including the open water portion of SWMU 2 (see Figure 2-3). Seagrass meadows within the Ensenada Honda are dominated by a nearly continuous cover of turtle grass with a high abundance of calcareous green algae (*Avranvilla* spp., *Ventricaria ventricosa*, *Caulerpa* spp., *Valonia* spp., and *Udotea* spp.) (Reid et al., 2001). The turtle grass climax meadows of the Ensenada Honda represent potential grazing areas for the West Indian manatee (*Trichechus manatus*), a federally endangered species in Puerto Rico.

(United States Fish and Wildlife Service [USFWS], 2009), and the green sea turtle (*Chelonia mydas*), a federally threatened species in Puerto Rico (USFWS, 2009).

2.2.3 Biota

A description of the biota occurring within Puerto Rico and the landmass encompassed by NAPR is provided in the sections that follow. This description is supplemented by information contained within the upland habitat characterization report for SWMU 2 included as Appendix A.

2.2.3.1 Mammals

A total of 22 terrestrial mammal species are known historically from Puerto Rico; however, all mammals except bats (13 species) have been extirpated (Mac et al., 1998). The specific bat species known to occur in Puerto Rico are listed below. None of the bats found in Puerto Rico are exclusive to the island, nor are they listed under provisions of the Endangered Species Act of 1973.

- Fruit-eating bats: Jamaican fruit bat (*Artibeus jamaicensis*), Antillean fruit bat (*Brachyphylla cavernarum*), and red fig-eating bat (*Stenoderma rufum*)
- Nectivorous bats: brown flower bat (*Erophylla sezekoni bombifrons*) and greater Antillean long-tounged bat (*Monophyllus redmani*)
- Insectivorous bats: Antillean ghost-faced bat (*Mormoops blainvillii*), Parnell's mustached bat (*Pteronotus parnellii*), sooty mustached bat (*Pteronotus quadridens*), big brown bat (*Eptesicus fuscus*), red bat (*Lasiurus borealis*), velvety free-tailed bat (*Molossus molossus*), and Brazilian free-tailed bat (*Tadarida brasiliensis*)
- Piscivorous bats: Mexican bulldog bat (*Noctilio leporinus*)

Of the endangered/threatened marine mammals that may occur in Puerto Rico, only the West Indian manatee is known to occur in the coastal waters surrounding NAPR (DoN, 2007). Manatee populations in Puerto Rico's coastal waters have been documented during three aerial surveys conducted from 1978 to 1979, 1984 to 1985, and in 1993 (United Nations Environmental Program [UNEP], 1995), a radio tracking study of manatee distribution and abundance (Reid and Kruer, 1998), and a year-long study of manatee distribution and abundance (Woods et al., 1984). Historical manatee sightings at NAPR are summarized on Figure 2-7. The figure (reproduced from DoN, 2007) includes information from most of the studies identified above. Feeding manatees are most often recorded within Pelican Cove and the Ensenada Honda (see Figure 2-7). Manatee sightings within the Ensenada Honda include locations within and contiguous to SWMU 2.

Several terrestrial mammals have been introduced into Puerto Rico, including the black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), and small Indian mongoose (*Herpestes javanicus*). These nonindigenous mammals have been implicated in the decline of native bird and reptile populations (Mac et al., 1998 and USFWS, 1996a).

2.2.3.2 Birds

A total of 239 bird species are native to Puerto Rico (Raffaele, 1989). This total includes breeding permanent residents and non-breeding migrants. In addition, many nonindigenous bird species have been introduced to Puerto Rico, including the shiny cowbird (*Molothrus bonariensis*) and several

parrot species, such as the budgerigar (*Melopsittacus undulatus*), orange-fronted parrot (*Aratinga canicularis*), and monk parrot (*Myiopsitta monachus*). Of the 239 species native to Puerto Rico, 12 are endemic to the island (Raffaele, 1989).

Numerous native and migratory bird species have been reported at NAPR (Geo-Marine, Inc., 1998). A list compiled from literature-based information pre-dating 1990 (see Table 2-1) includes the great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), little blue heron (*Florida caerulea*), black-crowned night heron (*Nycticorax nycticorax*), belted kingfisher (*Ceryle alcyon*), spotted sandpiper (*Actitis macularia*), greater yellowlegs (*Tringa melanoleuca*), black-bellied plover (*Squatarola squatarola*), clapper rail (*Rallus longirostris*), Royal tern (*Thalasseus maximus*), sandwich tern (*Thalasseus sandvicensis*), least tern (*Sterna albifrons*), yellow warbler (*Dendroica petechia*), palm warbler (*Dendroica palmarum*), prairie warbler (*Dendroica discolor*), magnolia warbler (*Dendroica magnolia*), mourning dove (*Zenaidura macroura*), red-legged thrush (*Mimocichla plumbea*), common nighthawk (*Chordeiles minor*), and red-tailed hawk (*Buteo jamaicensis*). Endemic species reported from NAPR include the Puerto Rican lizard cuckoo (*Saurothera vieilloti*), Puerto Rican flycatcher (*Myiarchus antillarum*), Puerto Rican woodpecker (*Malanerpes portoricensis*), Puerto Rican emerald (*Chlorostilbon maugaeus*), and yellow-shouldered blackbird (*Agelaius xanthomus*).

The yellow-shouldered blackbird is a federally endangered species. One of the principal reasons for the status of this species is attributed to parasitism by the nonindigenous shiny cowbird, which lays its eggs in blackbird nests and sometimes punctures the host's eggs (USFWS, 1983). Other factors contributing to the status of this species include nest predation by the introduced black rat, Norway rat, and mongoose, as well as habitat modification and destruction (USFWS 1996a). The entire land area of NAPR was declared critical habitat for the yellow-shouldered blackbird in 1976; however, a 1980 agreement with the USFWS exempted certain areas from this categorization (Geo-Marine, Inc., 1998). SWMU 2 is located within the critical habitat designation for the yellow-shouldered blackbird. A study conducted by the Naval Facilities Engineering Service Center (NFESC, 1996) reported that the mangrove forests surrounding NAPR should be considered the most important nesting habitat for the yellow-shouldered blackbird. Based on the arboreal feeding behavior of the yellow-shouldered blackbird, potential feeding habitat (shrub and tree layers within the upland coastal forest and mangrove communities) is present at the SWMU (Geo-Marine, Inc., 2000). A survey conducted by the Puerto Rico Department of Natural Resources (PRDNR) reported fifteen yellow-shouldered blackbirds (including five juveniles) at NAPR (PRDNR, 2002). At the time of the survey, the birds were using structures at the NAPR airport for resting cover. Although nesting pairs were not observed (the survey was not conducted during the breeding season), the airport structures contained several inactive nests. The inactive nests and juvenile birds indicate that a small breeding population is present at NAPR. Yellow-shouldered blackbirds were not observed within the upland coastal forest and estuarine wetland communities during the May 2000 habitat characterization (Geo-Marine, Inc., 2000).

Other federally listed bird species that occur or have the potential to occur at NAPR are the Caribbean brown pelican (*Pelecanus occidentalis occidentalis*), roseate tern (*Sterna dougallii dougallii*), and piping plover (*Charadrius melodus*) (Geo-Marine, Inc., 1998). The piping plover is a rare, non-breeding winter visitor in Puerto Rico (Raffaele, 1989). This species breeds only in North America in three geographic regions (Atlantic Coast population [threatened], Great Lakes population [endangered], and Northern Great Plains population [threatened]; USFWS, 1996b). No piping plover observations were reported at NAPR during the 1990s or during sea turtle nesting surveys conducted in 2002 and 2004 (Geo-Marine, Inc., 2005). No historic evidence is available to indicate whether the roseate tern (threatened in Puerto Rico) has ever nested at NAPR and no roseate tern observations have been noted in or over coastal waters adjacent to NAPR (DoN, 2007). The nearest active roseate tern colony likely occurs on the eastern end of Vieques (more than 20 miles east of NAPR) (DoN,

2007). The Caribbean brown pelican (endangered in Puerto Rico) appears to be a seasonal resident at NAPR and in the surrounding coastal waters (Geo-Marine, Inc., 2005). Small numbers, primarily juveniles, have been seen day-roosting, feeding, and resting irregularly in onshore and near-shore habitats at NAPR; however, no brown pelican nesting colonies have been found at NAPR or on the small cays nearby (Geo-Marine, Inc., 2005). Based on the habitat preferences and observations recorded at NAPR, only the brown pelican has the potential to use the open water habitat at SWMU 2 (i.e., Ensenada Honda) as a food source. It is important to note that the USFWS recently published a proposed rule to remove the brown pelican from the federal list of endangered and threatened wildlife throughout its range, including Puerto Rico (see Federal Register: Volume 73, Number 34, Pages 9408 dated February 20, 2008). This proposed rule indicates that special consideration of the brown pelican at NAPR is not warranted.

Several bird species were observed within the upland coastal forest and/or mangrove communities during the May 2000 habitat characterization (see Appendix A). Specific species observed within the vegetative communities included the red-tailed hawk, yellow warbler, Puerto Rican woodpecker, loggerhead kingbird (*Tyannus caudifasciatus*), zenaida dove, pearly-eyed thrasher (*Margarops fuscatus*), and black-whiskered vireo (*Vireo altiloquus*).

2.2.3.3 Reptiles and Amphibians

A total of 23 amphibians and 47 reptiles are known from Puerto Rico and the adjacent waters (Mac et al., 1998). Fifteen of the amphibians and 29 of the reptiles are endemic, while four amphibian species and three reptilian species have been introduced (Mac et al., 1998). Puerto Rico's native amphibian species include 16 species of tiny frogs commonly called coquis. On the coastal lowlands, almost all coqui species are arboreal. The only amphibians listed under provisions of the Endangered Species Act of 1973 are the Puerto Rican crested toad (*Peltophryne lemur*) and the golden coqui (*Eleutherodactylus jasperi*). Both species are listed as threatened (USFWS, 2009). Distribution of the golden coqui is restricted to areas of dense bromeliad growth. All specimens to date have been collected from a small semicircular area of a 6-mile radius south of Cayey (approximately 30 miles southwest of NAPR), generally at elevations above 700 meters (USFWS, 1984). The Puerto Rican crested toad occurs at low elevations (below 200 meters) where there is exposed limestone or porous, well drained soil offering an abundance of fissures and cavities (USFWS, 1987). A single large population is known to exist from the southwest coast in Guánica Commonwealth Forest, while a small population is believed to survive on the north coast near Quebradillas, Arecibo, Barceloneta, Vega Baja, and Bayamón (USFWS, 1987). It also has been collected on the southeastern coastal plain near Coamo (USFWS, 1987). Given the habitat preferences and locations of known occurrences, these two species are not expected to occur at NAPR.

Puerto Rico's native reptilian species include 31 lizards, 8 snakes, 1 freshwater turtle, and 5 sea turtles (Mac et al., 1998). Of the five sea turtles, only the green sea turtle, hawksbill sea turtle (*Eretmochelys imbricata*), and loggerhead sea turtle (*Dermochelys coriacea*) nest within Puerto Rico. These three sea turtles, as well as the leatherback sea turtle (*Caretta caretta*) are listed under the provisions of the Endangered Species Act of 1973 (hawksbill sea turtle and leatherback sea turtle are listed as endangered, while the green sea turtle [Caribbean population] and loggerhead sea turtle are listed as threatened) (USFWS, 2009). Aerial surveys of turtles were performed from March 1984 through March 1995 along the Puerto Rican Coast. This information was summarized by Geo-Marine, Inc. (2005) in the Draft NAPR Disposal Environmental Assessment (EA). Figures 2-8 and 2-9 (reproduced from Geo-Marine, Inc., 2005) present cumulative sea turtle sightings and potential turtle nesting sites at NAPR. Significant turtle observations were made near the mouth of the Ensenada Honda, the northern shore of Pineros Island, Pelican Bay, and the Medio Mundo Passage, with the frequency of turtle observations listed as green > hawksbill > loggerhead > leatherback.

Based on the life history information for each turtle species (see Baker, 2007) and the availability of forage material (in the form of seagrass), the green sea turtle has the potential to forage within the Ensenada Honda, including the open water portion of SWMU 2.

The Puerto Rican boa (*Epicrates inornatus*) is a federally endangered species throughout its entire range (critical habitat has not been designated for this species [USFWS, 1986b]). Four Puerto Rican boa sightings were reported at NAPR prior to 1999 and an additional four occurrences were reported between 2001 and 2003 (Geo-Marine, Inc., 2005). However, no boas were observed during 211 man-hours of surveys conducted within potential boa habitat in 2004 (Tolson, 2004). The Puerto Rican boa uses a variety of habitats but is most commonly found in Karst forest habitat (forested limestone hills). Based on the absence of preferred habitat, there is low probability of occurrence of this species at SWMU 2. Several lizard species were observed with the upland habitat at SWMU 2 during the May 2000 habitat characterization (Geo-Marine, Inc., 2000); these included the crested anole (*Anolis cristatellus*), barred anole (*Anolis stratulus*), and garden lizard (*Anolis pulchellus*). Two amphibian species (i.e., frogs) were also observed within the upland coastal forest community at SWMU 2 (*Eleutherodactylus* spp. and the Caribbean white-lipped frog [*Leptodactylus albilabris*]).

2.2.3.4 Fish and Aquatic Invertebrates

A diverse fish and invertebrate community can be found in the marine environment surrounding NAPR. This can be attributed to the varied habitats that include marine and estuarine open water habitat, mud flats, seagrass beds, and mangrove forests. The fish community is represented by stingrays, herrings, groupers, needlefish, mullets, barracudas, jacks, snappers, grunts, snooks, lizardfishes, parrotfishes, gobies, filefishes, wrasses, damselfishes, and butterflyfish (Geo-Marine, Inc., 1998). The benthic invertebrate community includes sponges, corals, anemones, sea cucumbers, sea stars, urchins, and crabs. A list of known species residing within the estuarine wetland and open water marine habitats at SWMU 2 is not available. However, numerous fiddler crabs (*Uca* spp.) have been observed within the black and red mangrove communities at and contiguous to SWMU 2 during previous field investigations (Baker, 2006a)

2.3 Ecological Chemicals of Concern

The SERA and Step 3a of the BERA (Baker, 2006a) evaluated the aquatic (estuarine wetland and open water habitat) and terrestrial habitat (upland coastal forest community) associated with SWMU 2. The assessment endpoints, risk questions, and measurement endpoints selected for the SERA are summarized in Table 2-2. As evidenced by Table 2-2 assessment endpoints were not established for fish within the SWMU 2 estuarine wetland system. Although sediments within the wetland were saturated, standing water was not present within the area of investigation during the 2003 and 2004 additional data collection field investigations. Because the area of investigation is incapable of supporting a fish community, assessment and measurement endpoints also were not established for piscivorous birds such as the belted kingfisher, green heron, and great blue heron.

The ERA used analytical data from the following field investigations (see Table 2-3 and Figure 2-10):

- 1992 Supplemental Investigation (SI): Surface Soil (0.0 to 0.5 foot depth interval) and subsurface soil (0.5 to 1.5-foot depth interval)
- 1996 RCRA Facility Investigation (RFI): Surface soil (0.0 to 1-foot depth interval)
- 2003 Additional Data Collection Investigation: Surface water (open water habitat) and sediment (estuarine wetland and open water habitats)

- 2004 Additional Data Collection Investigation: Surface soil (0.0 to 1.0-foot depth interval), subsurface soil (1.0 to 2.0-foot depth interval), and sediment (estuarine wetland habitat)

Analytical data from the 1992 SI and 1996 RFI Field Investigation were presented and discussed in the *Revised Draft RCRA Facility Investigation Report for Operable Unit 3/5* (Baker, 1999), while analytical data from the 2003 and 2004 additional data collection investigations were presented and discussed in the *Final Additional Data Collection and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2* (Baker, 2006a). As noted in Table 2-3, three samples collected during the 1996 RFI and identified as sediment (i.e., 2SD01 through 2SD03) were re-designated and evaluated as surface soil in the SERA and Step 3a of the BERA (Baker 2006a) based on observations made in the field during the 2003 additional data collection investigation (i.e., samples were collected from vegetated swales containing upland vegetation). Although re-designated and evaluated as surface soil, the sample identification numbers assigned to these samples during the 1996 RFI field investigation were not changed. A summary of the SERA and Step 3a evaluation is provided below. Results also are summarized in Table 2-4 for those receptors/receptor groups quantitatively evaluated.

Antimony, copper, lead, mercury, and zinc in surface soil and subsurface soil were identified as ecological COCs in Step 3a of the BERA for terrestrial invertebrate and plant communities based on the magnitude and frequency of detections above soil screening values, maximum and mean hazard quotient (HQ) values greater than 1.0, and/or results of statistical comparisons to background analytical data. Surface and subsurface soil analytical data for the ecological COCs are presented in Tables 2-5 and 2-6, respectively. Screening-level risk estimates for the ecological COCs are summarized in Tables 2-7 (surface soil) and 2-8 (subsurface soil), while ecological COC detections above the soil screening values used in Step 2 of the SERA and Step 3a of the BERA are depicted on Figures 2-11 (surface soil) and 2-12 (subsurface soil).

In addition to terrestrial plants and invertebrates, the SERA and Step 3a of the BERA also evaluated potential food web exposures to chemicals in SWMU 2 surface and subsurface soil by upper trophic level terrestrial receptors (i.e., avian herbivores, omnivores, and carnivores [see Table 2-2]). The mourning dove was selected to represent avian herbivores, while the American robin (*Turdus migratorius*) and red-tailed hawk were selected to represent avian omnivores and carnivores, respectively. Lead, mercury, and zinc in surface soil were identified as ecological COCs for terrestrial avian omnivore (American robin) and herbivore (mourning dove) food web exposures based on maximum and/or mean no observed adverse effect level (NOAEL)-based HQ values greater than 1.0 (see Table 2-9). Copper, lead, and zinc in subsurface soil also were identified as ecological COCs for terrestrial avian omnivore and herbivore food web exposures (see Table 2-10 for maximum and mean NOAEL-based HQ values). Surface and subsurface soil analytical data for chemicals identified as ecological COCs for terrestrial avian omnivore and herbivore food web exposures are included in Tables 2-5 and 2-6, respectively. No chemical was identified as an ecological COC for terrestrial avian carnivore dietary exposures (Baker, 2006a). As evidenced by Table 2-2, terrestrial amphibians and reptiles were qualitatively evaluated in the SERA by examination of exposures and risks to ecological receptors occupying similar trophic levels. Based on the presence of potential risks to terrestrial avian herbivores and omnivores, terrestrial amphibians and reptiles were retained for additional evaluation in Step 3b of the ERA process.

The SERA and Step 3a of the BERA also evaluated lower trophic level aquatic receptor group and upper trophic level receptor exposures to chemicals in SWMU 2 estuarine wetland sediment. The aquatic receptor groups evaluated were aquatic plants and invertebrates (as was previously discussed, fish were not evaluated in the SERA based on the absence of standing water within the area of investigation). The upper trophic level receptor evaluated for estuarine wetland food web exposures

was the spotted sandpiper (avian invertivore). The SERA and Step 3a of the BERA identified copper, lead, and zinc in estuarine wetland sediment as ecological COCs for benthic invertebrates and plants based on the magnitude and frequency of detections above sediment screening values, maximum and mean HQ values greater than 1.0, results of statistical comparisons to background analytical data, and/or an evaluation of acid volatile sulfide (AVS) and simultaneously extracted metals (SEM) analytical data. Estuarine wetland sediment analytical data for chemicals identified as ecological COCs are presented in Tables 2-11. Screening-level risk estimates for the ecological COCs are summarized in Table 2-12, while ecological COC detections greater than the sediment screening values used in Step 2 of the SERA and Step 3a of the BERA are depicted on Figure 2-13. Based on the evaluation of potential risks to upper trophic level receptors, lead and mercury were identified as ecological COCs for aquatic avian invertivores (maximum NOAEL-based HQ values = 21.3 for lead and 103 for mercury; mean HQ values = 2.12 for lead and 5.39 for mercury). Estuarine wetland sediment analytical data for chemicals identified as ecological COCs for avian invertivore food web exposures are included in Table 2-11.

Finally, the SERA and Step 3a of the BERA evaluated lower trophic level aquatic receptor group and upper trophic level receptor exposures to chemicals in surface water and sediment within the open water habitat associated with SWMU 2 (i.e. Ensenada Honda). The aquatic receptor groups evaluated were aquatic plants, invertebrates, and fish. The upper trophic level receptors evaluated for Ensenada Honda food web exposures were the double-crested cormorant (avian piscivore) and West Indian manatee (mammalian herbivore). Ecological COCs were not identified for any of the lower trophic level aquatic receptor groups evaluated by the SERA and Step 3a of the BERA and no further evaluation was recommended. In addition, no chemicals were identified as ecological COCs for double-crested cormorant dietary exposures. However, arsenic, mercury, and selenium in open water sediment were identified as ecological COCs for West Indian manatee food web exposures based on maximum NOAEL-based HQ values greater than 1.0 (HQ values = 35.6 for arsenic, 1.71 for mercury, and 1.52 for selenium). Cadmium, copper, lead, and zinc also were identified as ecological COCs for West Indian manatee food web exposures based on maximum NOAEL-based HQ values derived using toxicity reference values (TRVs) adjusted to (1) reflect interspecies differences between the test species and the receptor species, and (2) the endangered status of the West Indian manatee (maximum adjusted NOAEL-based HQ values = 3.43 for cadmium, 1.26 for copper, 4.56 for lead, and 3.11 for zinc). Open water sediment analytical data for chemicals identified as ecological COCs for West Indian manatee food web exposures are presented in Table 2-13. Although aquatic reptiles (i.e., sea turtles [green, hawksbill, leatherback, and loggerhead sea turtles]) were not quantitatively evaluated in the SERA and Step 3a of the BERA, additional evaluation was recommended in Step 3a of the ERA process based on the presence of potentially complete exposure pathways and the status of sea turtles in Puerto Rico (threatened or endangered).

2.4 Conceptual Model

Information on the SWMU's habitat features and the fate and transport of ecological COCs, as well as information on key exposure pathways, routes, and receptor groups are used to refine the preliminary conceptual model developed in Step 1 of the ERA. A graphical representation of the conceptual model for SWMU 2 is presented as Figure 2-14. The figure illustrates the primary functional components of the terrestrial and aquatic ecosystems at SWMU 2. The model has been revised to reflect the results of the SERA and Step 3a of the BERA and focuses on the contaminant-receptor combinations where the potential for unacceptable risk has been identified. Components of the conceptual model are described in the sections that follow.

2.4.1 Contaminant Fate and Transport and Toxicity Evaluation

The sections that follow include an evaluation of the fate and transport and toxicity of the chemicals identified as ecological COCs in Step 3a of the BERA (antimony, arsenic, cadmium, copper, lead, mercury, selenium, and zinc). The toxicity evaluations focus on the chemical-receptor combinations that have the potential for unacceptable impacts (i.e., terrestrial plants and invertebrates: antimony, copper, lead, mercury, and zinc in SWMU 2 surface and subsurface soil; terrestrial avian omnivores and herbivores: lead, mercury, and zinc in SWMU 2 surface soil and copper, lead, and zinc in SWMU 2 subsurface soil; benthic invertebrates: copper, lead, and zinc in estuarine wetland sediment; aquatic avian invertivores: lead and mercury in estuarine wetland sediment; West Indian manatee: arsenic, cadmium, copper, lead, mercury, selenium, and zinc in Ensenada Honda sediment).

2.4.1.1 Antimony

Antimony and its compounds are naturally present in the earth's crust. Although releases to the environment occur from natural processes (e.g., volcanic eruptions), most of the antimony released to the environment is from anthropogenic activities, including metal smelting and refining, coal combustion, and refuse incineration (Agency for Toxic Substances and Disease Registry [ATSDR], 1992).

Antimony displays four oxidation states: Sb^{3-} , Sb^0 , Sb^{3+} , and Sb^{5+} . The +3 and +5 oxidation states are the most common and stable. Little is known of the adsorptive behavior of antimony, its compounds, and ions. The binding of antimony to soil and sediment is primarily correlated with the iron, manganese, and aluminum content as it co-precipitates with hydroxylated oxides of these elements (ATSDR, 1992). Some forms of antimony may bind to inorganic and organic ligands. Mineral forms are unavailable for binding. Some studies suggest that antimony is fairly mobile under diverse environmental conditions, while others suggest that it is strongly adsorbed to soil (ATSDR, 1992). Uptake from soil by plants is minor and appears to be correlated with the amount of available antimony (that which is soluble or easily exchangeable). Studies have shown that antimony does not biomagnify from lower to higher trophic levels in terrestrial food chains (ATSDR, 1992).

As a natural constituent of soil, antimony is transported into streams and waterways from weathering of soil as well as from anthropogenic sources. The forms of antimony and the chemical and biochemical process that occur in the aquatic environment are not well understood. Antimony in both aerobic freshwater and seawater is largely in the +5 oxidation state, although antimony in the +3 oxidation state does occur in these waters. Under reducing conditions, trivalent species such as $\text{Sb}(\text{OH})_3$, $\text{Sb}(\text{OH})_4^{1-}$, and $\text{Sb}_2\text{S}_4^{4-}$ may be significant (Andreae and Froehlich, 1984). Antimony can be reduced and methylated by microorganisms in the aquatic environment and become mobilized (Andreae et al., 1983 and Austin and Millward, 1988). This reaction is most likely to occur in reducing environments, such as bed sediments. Antimony does not appear to bioconcentrate appreciably in fish and aquatic organisms (ATSDR, 1992).

Antimony in SWMU 2 surface and subsurface soils has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3b of the BERA.

- 5.0 milligram per kilogram (mg/kg): Toxicological benchmark for terrestrial plants (Efroymson et al., 1997a)
- 78 mg/kg: Ecological Soil Screening Level (SSL) for soil invertebrates (USEPA, 2005a)

2.4.1.2 Arsenic

Arsenic is a naturally occurring element that exists mainly in rock or soil and cycles biogeochemically via oxidation and reduction (Eisler, 1988). Arsenate (pentavalent, As^{+5}) is the predominant inorganic form in oxygenated water (where it will be chemically bound to soil or sediment particles) and arsenite (trivalent, As^{+3}) is the predominant arsenic form under anaerobic conditions (USEPA, 1981). Arsenite is water soluble and therefore more mobile and is considered to be the more toxic form (USEPA, 1999). Arsenic is readily adsorbed onto sediments with high organic matter and those with high clay content, sulphur, manganese, iron oxides and aluminum hydroxides (USEPA, 1999 and MacDonald, 1994). Adsorption and release also depend on the arsenic concentration, pH, oxidation-reduction potential (Eh), temperature, salinity, and the ionic concentration of other compounds (ATSDR, 2005a and Eisler, 1988). Transportation within the aquatic environment for bound arsenic, therefore, is largely a function of suspended sediment dynamics or larger-scale erosive events. Changes in the oxidative state and/or biological interactions can release arsenic back into the water column.

In soils, arsenic uptake is dependent upon the form of arsenic available and the physical and chemical properties of the soil, including organic carbon and clay content. Higher organic material and clay content favor binding within the soil as immobile forms, and thus less potential for uptake (USEPA, 1999). Arsenic is generally not bioavailable to aquatic organisms under aerobic conditions (MacDonald, 1994). Arsenic may bioaccumulate in lower trophic level organisms; however, data does not indicate that significant biomagnification occurs (USEPA, 1999), especially in aquatic food chains. Once within the mammalian body, arsenic readily moves through the body and does not preferentially accumulate in any organs (USEPA, 1999). Arsenic is metabolized (methylated) readily in the liver of mammals to less toxic forms and is subsequently rapidly eliminated (USEPA, 1999). As such, the potential for bioaccumulation in mammalian tissues is minimal. Identified impacts to aquatic organisms include growth, reproduction, behavioral, mutagenic, and carcinogenic effects (MacDonald, 1994).

Based on the SERA and Step 3a of the BERA (Baker, 2006a), arsenic in SWMU 2 open water sediment (i.e., Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of arsenic ingestion by mammals. Neiger and Osweiler (1989; as cited in USEPA 2005b) investigated the effect of arsenic on growth in dogs (*Canis familiaris*). A dose of 1.04 milligrams per kilogram-body weight per day (mg/kg-BW/day) had no effect on body weight. This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2005b). Neiger and Osweiler (1989) reported adverse effects (i.e., reduced body weight) at a dose of 1.66 mg/kg-BW/day. This dose is considered a chronic lowest observed adverse effect level (LOAEL). The study by Neiger and Osweiler (1989) forms the basis of the NOAEL (1.04 mg/kg-BW/day) and LOAEL (1.66 mg/kg-BW/day) developed for West Indian manatee dietary exposures to arsenic in SWMU 2 open water sediment (see Section 2.5.4).

2.4.1.3 Cadmium

Cadmium is a naturally occurring element found in phosphate rock. It is used in many industrial applications, including alloy manufacturing, batteries, plastics, paints, fuels, and agricultural products, including fertilizers. It exhibits low vapor pressure and is found in two valence states: Cd^{+0} (metallic/elemental) or Cd^{+2} (divalent). Cadmium is persistent in the environment and is generally stable in soil (ATSDR, 1999a). Terrestrial transformation processes include precipitation,

complexation, ion exchange, and dissolution (USEPA, 1999). In the aquatic environment, cadmium is found as a component of organic compounds and as inorganic sulfides, oxides, and halides. Photodegradation and biological degradation are generally not important. Cadmium sorbs to sedimentary particles and precipitates with aluminum, manganese, and iron oxides (MacDonald, 1994 and ATSDR, 1999a). The bioavailability of cadmium is dependent on the chemical and physical properties of the aquatic environment, including redox potential, water hardness, and pH (MacDonald, 1994). The presence of AVS in sediment (a complexing agent that is found under reducing conditions) has been identified as an important factor governing the bioavailability of cadmium (Di Toro et al., 1991 and Ankley et al., 1996).

Freshwater aquatic species are generally more sensitive to the toxic effects of cadmium than marine species; toxicity in freshwater environments is inversely proportional to the water hardness (USEPA, 1999). Survival, growth, reproduction, and behavioral impacts have been noted for marine invertebrates (MacDonald, 1994). Diatoms and aquatic plants also show impaired growth and development. Cadmium can cross the placental barrier in mammals and is a reproductive toxin in fish and other aquatic life. Other adverse effects in upper trophic level aquatic organisms include interference with the kinetics of other metals and decreased oxygen utilization, as well as bone marrow, heart, kidney, and vascular impacts (USEPA, 1999). Though elimination from the body does occur, cadmium can concentrate in tissues and thus can bioaccumulate in food chains. An inverse relationship between cadmium uptake via dietary exposures and uptake of iron and calcium has been noted (USEPA, 1999). Vertebrates tend to accumulate cadmium in the kidney and liver (Eisler, 1985).

Based on the SERA and Step 3a of the BERA (Baker, 2006a), cadmium in SWMU 2 open water sediment (i.e., Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of cadmium ingestion by mammals. A 2-week study investigating the effect of cadmium on growth in rats indicated that a dose of 0.77 mg/kg-BW/day (oral in water) had no adverse effect on body weight change (Yuhas et al., 1979 as cited in USEPA, 2005c). This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2005c). Yuhas et al. (1979) reported adverse effects (i.e., reduced body weight) at a dose of 7.70 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Yuhas et al. (1979) forms the basis of the NOAEL (0.77 mg/kg-BW/day) and LOAEL (7.70 mg/kg-BW/day) developed for West Indian manatee food web exposures to cadmium in SWMU 2 open water sediment (see Section 2.5.4).

2.4.1.4 Copper

Copper is a common metallic element found in crustal rocks and minerals. Natural sources of copper in the environment include weathering of copper-bearing minerals, copper sulfides, and native copper. Anthropogenic sources include corrosion of brass and copper pipe by acidic waters, the use of copper compounds as aquatic algicides, runoff and groundwater contamination from agricultural uses of copper as fungicides, and atmospheric fallout from industrial sources.

Copper exists in four oxidation states: Cu^0 , Cu^{1+} , Cu^{2+} , and Cu^{3+} (Eisler, 1998a). Copper's movement in soil is determined by a host of physical and chemical interactions with soil components. In general, copper will absorb to organic matter, carbonate minerals, clay minerals, or hydrous iron and manganese oxides (ATSDR, 2004). Sandy soils with low pH have the greatest potential for leaching. The cupric ion (Cu^{2+}) is the oxidation state generally encountered in water and it is the most readily available and toxic inorganic species of copper. Toxicity in freshwater systems is inversely

proportional to water hardness. Copper may form associations with organic matter and precipitates of hydroxides, phosphates, and sulfides. Formation of these complexes tends to facilitate transport to sediments. Bioavailability in sediment is controlled by the degree of complexation with AVS and adsorption to organic matter (USEPA, 2000a). Copper is an essential micronutrient, and, therefore, is readily accumulated by aquatic organisms. However, no evidence exists to suggest that copper is biomagnified in aquatic ecosystems (Jaagumagi, 1990).

Copper is taken up by mammals primarily through dietary exposure. Most organisms retain only a small proportion of copper ingested with their diet. Once ingested, copper travels through the gastrointestinal tract, where some of it is absorbed into the blood and becomes associated with plasma albumin and amino acids. Albumin-bound copper is eventually transported to the liver where 80 percent is bounded to metallothionein, with the remainder incorporated into enzyme compounds. In mammals, copper is excreted via the bile.

Based on the SERA and Step 3a of the BERA (Baker, 2006a), copper in SWMU 2 surface and subsurface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3a of the BERA.

- 50 mg/kg: Toxicological threshold for earthworms (Efroymson et al., 1997b)
- 70 mg/kg: Ecological SSL for terrestrial plants (USEPA, 2007a)
- 80 mg/kg: Ecological SSL for soil invertebrates (USEPA, 2007a)
- 100 mg/kg: Toxicological threshold for terrestrial plants (Efroymson et al., 1997a)

Copper in SWMU 2 estuarine wetland sediment also has the potential to impact aquatic invertebrates (i.e., benthic macroinvertebrates). Available literature-based marine/estuarine toxicological benchmarks for aquatic invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3b of the BERA.

- 18.7 mg/kg: Threshold Effects Level (TEL) marine sediment quality guideline (MacDonald, 1994)
- 34 mg/kg: Effects Range-Low (ER-L) marine and estuarine sediment quality guideline (Long et al., 1995)
- 108 mg/kg: Probable Effect Level (PEL) marine sediment quality guideline (MacDonald, 1994)
- 270 mg/kg: Effects Range-Median (ER-M) marine and estuarine sediment quality guideline (Long et al., 1995)
- 390 mg/kg: Apparent Effects Threshold (AET) marine sediment quality guideline (Buchman, 1999)

In addition to terrestrial and aquatic invertebrates, copper in SWMU 2 subsurface soil has the potential to impact terrestrial avian herbivores and omnivores. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of copper ingestion by birds. An 84-day study using leghorn chickens (*Gallus domesticus*) indicated that a dose of 4.05 mg/kg-BW/day (oral in diet) had no effect on egg production (Ankari et al., 1998 as cited in USEPA, 2007a). This dose, selected by the USEPA as the TRV for avian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2007a). Ankari et al. (1998) reported impaired egg production at a dose of 12.1 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Ankari et al. (1998) forms the basis of the NOAEL (4.05 mg/kg-BW/day) and LOAEL (12.1 mg/kg-BW/day) developed for avian dietary exposures to copper in SWMU 2 subsurface soil (see Section 2.5.4).

Finally, copper in SWMU 2 open water sediment (i.e. Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of copper ingestion by mammals. A 4-week survival and growth study using the pig (*Sus scrofa*) indicated that a dose of 5.6 mg/kg-BW/day (oral in diet) had no effect on survival and body weight change (Allcroft et al., 1961 as cited in USEPA, 2007a). This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2007a). Allcroft et al. (1961) reported adverse effects on survival and growth at a dose of 9.34 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Allcroft et al. (1961) forms the basis of the NOAEL (5.6 mg/kg-BW/day) and LOAEL (9.34 mg/kg-BW/day) developed for West Indian manatee dietary exposures to copper in SWMU 2 open water sediment (see Section 2.5.4).

2.4.1.5 Lead

Lead exists in three oxidation states: elemental (Pb^0), divalent (Pb^{+2}), and tetravalent (Pb^{4+}). In the environment, lead primarily exists as Pb^{2+} . Lead is dispersed throughout the environment primarily as the result of anthropogenic activities. Anthropogenic sources include mining and smelting of ore, manufacture of lead-containing products, combustion of coal and oil, and waste incineration. Many anthropogenic sources of lead, most notably leaded gasoline, lead-based paint, lead solder in food cans, lead-arsenate pesticides, and shot and sinkers, have been eliminated or strictly regulated due to lead's persistence and toxicity (ATSDR, 2005b).

The fate of lead in soil is affected by the adsorption at mineral interfaces, the precipitation of sparingly soluble solid forms of the compound, and the formation of relatively stable organic-metal complexes with soil organic matter (ATSDR, 2005b). These processes are dependent on such factors as soil pH, soil type, particle size, organic matter content, the presence of inorganic colloids and iron oxides, and cation exchange capacity. Most lead is retained strongly in soil, and very little is transported through runoff to surface water or leaching to groundwater except under acidic conditions; however, lead may enter surface waters as a result of erosion of lead-containing soil particles.

Lead exists in three forms in water: (1) dissolved (e.g., Pb^{2+} , $PbOH^{1+}$, $PbCO_3$), which generally results from atmospheric deposition and runoff; (2) dissolved bound (e.g., colloids or strong complexes); and (3) particulate (Eisler, 1998b). Particulate and bound forms are common in urban runoff and ore-mining effluents. Lead is most soluble and bioavailable under conditions of low pH, low organic content, low concentrations of suspended sediments, and low concentrations of the salts of calcium, iron, manganese, zinc, and cadmium (Eisler, 1998b). Common forms of dissolved lead

are lead sulfate, lead chloride, lead hydroxide, and lead carbonate, but the distribution of salts is highly dependent on the pH of the water. The speciation of lead differs in freshwater and seawater. In fresh water, lead may partially exist as the divalent cation (Pb^{2+}) at pH values below 7.5, but complexes with dissolved carbonate to form insoluble PbCO_3 under alkaline conditions (ATSDR, 2005b). Lead chloride and lead carbonate are the primary complexes formed in seawater.

Most lead entering water is precipitated to sediment in the form of carbonate and hydroxide complexes. Factors affecting the degree of sorption in sediments include pH, organic carbon content, cation exchange capacity, and the presence of other constituents such as metal oxides, aluminum silicates, carbonates, and AVS. Lead can be mobilized and released from sediment with sudden pH decreases or ionic composition changes. Sorption is higher in sediments containing clay, and lower in sediments containing a higher percentage of sand (Eisler, 1998b). The amount of bioavailable lead in sediment is controlled, in large part, by the concentration of AVS and organic matter. Some Pb^{2+} in sediment may be transformed to tetraalkyl lead compounds, including tetramethyl lead, through chemical and microbial processes. However, most organolead compounds result from anthropogenic inputs. In water, tetraalkyl lead compounds are subject to photolysis and volatilization. Lead is accumulated by aquatic organisms equally from water and through dietary exposure (USEPA, 2000a). Lead does not biomagnify to a great extent in food chains, although accumulation by plants and animals has been extensively documented (Eisler, 1998b).

Based on the SERA and Step 3a of the BERA (Baker 2006a), lead in SWMU 2 surface and subsurface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3a of the BERA.

- 50 mg/kg: Toxicological threshold for terrestrial plants (Efroymson et al., 1997a)
- 120 mg/kg: Ecological SSL for terrestrial plants (USEPA, 2005d)
- 500 mg/kg: Toxicological threshold for earthworms (Efroymson et al., 1997b)
- 1,700 mg/kg: Ecological SSL for soil invertebrates (USEPA, 2005d)

Lead in SWMU 2 estuarine wetland sediment also has the potential to impact aquatic invertebrates (i.e., benthic macroinvertebrates). Available literature-based marine/estuarine toxicological benchmarks for aquatic invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3b of the BERA.

- 30.2 mg/kg: TEL marine sediment quality guideline (MacDonald, 1994)
- 47 mg/kg: ER-L marine and estuarine sediment quality guideline (Long et al., 1995)
- 112 mg/kg: PEL marine sediment quality guideline (MacDonald, 1994)
- 218 mg/kg: ER-M marine and estuarine sediment quality guideline (Long et al., 1995)
- 400 mg/kg: AET marine sediment quality guideline (Buchman, 1999)

In addition to terrestrial and aquatic invertebrates, lead in SWMU 2 surface and subsurface soil has the potential to impact terrestrial avian herbivores and omnivores via dietary (food web) exposures, while lead in SWMU 2 estuarine wetland sediment has the potential to impact aquatic avian invertebrates via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of lead ingestion by birds. A 4-week study investigating the effect of lead on leghorn chicken reproduction indicated that a dose of 1.63 mg/kg-BW/day (oral in diet) had no effect on egg production (Edens and Garlich, 1983 as cited in USEPA, 2005d). This dose, selected by the USEPA as the TRV for avian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2005d). Edens and Garlich (1983) reported impaired egg production at a dose of 3.26 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Edens and Garlich (1983) forms the basis of the NOAEL (1.63 mg/kg-BW/day) and LOAEL (3.26 mg/kg-BW/day) developed for terrestrial avian dietary exposures to lead in SWMU 2 surface and subsurface soil (see Section 2.5.4).

Finally, the SERA and Step 3a of the BERA (Baker, 2006a) indicated that lead in SWMU 2 open water sediment (i.e., Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of lead ingestion by mammals. A 7-week study investigating the effect of lead on the growth of 21-day old gestational rats indicated that a dose of 4.70 mg/kg-BW/day had no effect on body weight (Kimmel et al., 1980 as cited in USEPA, 2005d). This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival (USEPA, 2005d). Kimmel et al., 1980 reported impaired body weight at a dose of 8.90 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Kimmel et al. (1980) forms the basis of the NOAEL (4.70 mg/kg-BW/day) and LOAEL (8.90 mg/kg-BW/day) developed for West Indian manatee dietary exposures to lead in SWMU 2 open water sediment (see Section 2.5.4).

2.4.1.6 Mercury

Mercury is a naturally occurring element found in cinnabar, a sulfide mineral. Industrial applications and uses include paint manufacturing, paper industry, electrical equipment, batteries, thermometers, and at one time, pesticides (MacDonald, 1994). Transport pathways to the aquatic environment include waste dumping and incineration, mining, smelting, and coal combustion. It is persistent in the environment and is found in three states naturally: Hg^0 (metallic/elemental), Hg^{+1} (mercurous), and Hg^{+2} (mercuric [Hg(II)]). Elemental mercury is unique among metals in being liquid at ambient temperature and being quite volatile. It partitions strongly to air in the environment and is not found in nature as a pure, confined liquid. Of the two ionic forms of mercury (mercurous and mercuric mercury), the mercuric form is more environmentally stable, and therefore predominates. Mercuric mercury is the dominant form in surface water (ATSDR, 1999b). In sediment, mercury is generally found adsorbed to particulate matter. Sorption to particulates immobilizes mercury and is dependent on the presence of organic matter, complexing agents (sulfides) and clay fractions. Bacterial metabolism and chemical reduction can mobilize sorbed mercury from particulate matter to more volatile forms. Ionic mercury (i.e., mercuric mercury) can be transformed to methylmercury (MeHg) by anaerobic, sulfur-reducing bacteria, which produce MeHg as a byproduct of their natural sulfur chemistry (Gilmour and Henry, 1991, Gilmour et al., 1992, and Zillioux et al., 1993). The major site of methylation in aquatic systems is the sediment, but methylation also occurs in the water column (Wright and Hamilton, 1992, Parks et al., 1989, and Gilmour and Henry, 1991). Once MeHg is produced, it can either be demethylated via biotic and abiotic mechanisms (Sellers et al., 1996) or enter into the food web. The rate of mercury methylation is influenced by a number of environmental

factors that affect both the availability of mercuric ions for methylation and the growth of the methylating microbial populations:

- Bacterial methylation rates appear to increase under anaerobic conditions (oxygen-poor environments exhibit a reducing electrochemical potential that favors sulfur metabolism by sulfur-reducing bacteria).
- Sulfate stimulates formation of methylmercury (sulfate is used by sulfur-reducing bacteria in their metabolic process).
- Increasing water temperature enhances bacterial activity, thereby increasing the formation of methylmercury.
- The presence of organic matter can stimulate growth of microbial populations (and reduce oxygen levels), thereby increasing the formation of MeHg.
- Increasing hydrogen ion concentrations increase the formation of MeHg (Xun et al., 1987 and Winfrey and Rudd, 1990) by enhancing mercury uptake by bacteria (Kelly et al., 2003).
- Sulfide inhibits MeHg formation by binding with inorganic mercury ions and forming an insoluble mercury-sulfide complex, thereby limiting the bioavailability of inorganic mercury to sulfur-reducing bacteria.

MeHg is the most bioavailable and toxic form of mercury. Based on the relationship between MeHg production and total mercury concentration, the proportion of mercury as MeHg in sediment and associated organisms has been found to be proportional to the distance from the mercury source (Hill et al., 1996). In addition, organisms at lower trophic levels usually contain the lowest proportion of total mercury as MeHg (May et al., 1987 and Watras and Bloom, 1992), while organisms higher in the food chain (i.e., piscivorous fish, birds, mammals) contain a higher proportion of total mercury as MeHg (generally over 90 percent of the total mercury [Huckabee et al., 1979, Watras and Bloom, 1992, Bloom, 1990, and Grieb et al., 1990]). Several studies have been identified which investigated total mercury and MeHg concentrations in seagrass species. Season variations in both total mercury and MeHg concentrations have been identified and concentrations are generally greater in the older plant material and in the root mat (Ferrat et al., 2002, Capiomont et al., 2000, and Pannhorst and Weber, 1999). Partitioning of MeHg as a function of total mercury does not appear to be a factor between above ground (shoots, leaves, stems) and below ground (roots and rhizomes) portions of the plants (6.9 percent MeHg in above ground eelgrass tissue, 6.4 percent MeHg in below ground tissue [Pannhorst and Weber, 1999]).

A variety of adverse biological effects have been attributed to mercury. Enzymatic impacts have been noted in aquatic plants (Ferrat et al., 2002). Mercury is a known teratogen, mutagen, and carcinogen. The reproduction, growth, metabolism, blood chemistry, and oxygen exchange of marine and freshwater organisms is adversely affected by mercury. Mercury readily bioaccumulates and elimination from mammalian systems is slow (USEPA, 1999). Retention times appear to be longer for MeHg than for inorganic forms. Biological half-lives of 2 to 3 years in fish have been reported (USEPA, 1999).

Based on the SERA and Step 3a of the BERA (Baker, 2006a), mercury in SWMU 2 surface and subsurface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order

of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3b of the BERA.

- 0.1 mg/kg: Toxicological benchmark for earthworms (Efroymson et al., 1997b)
- 0.3 mg/kg: Toxicological benchmark for terrestrial plants (Efroymson et al., 1997a)

Mercury in SWMU 2 surface soil also has the potential to impact terrestrial avian herbivores and omnivores via dietary (food web) exposures, while mercury in SWMU 2 estuarine wetland sediment has the potential to impact aquatic avian invertivores via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of mercury ingestion by birds. Studies by Heinz (1975, 1976a, 1976b, and 1979 as referenced in USEPA [1997b]), in which three generations of mallard ducks (*Anas platyrhynchos*) were dosed with MeHg dicyandiamide, indicated that the lowest dose tested (0.078 mg/kg-BW/day) resulted in adverse effects on reproduction and behavior. This value was designated as a chronic LOAEL (USEPA, 1997b). USEPA (1997b) estimated a chronic NOAEL (0.026 mg/kg-BW/day) by applying a LOAEL-to-NOAEL uncertainty factor of three to the chronic LOAEL. A second study using Japanese quail (one-year reproductive study with mercuric chloride) indicated that a dose of 0.45 mg/kg-BW/day (oral in diet) had no effect on fertility and egg hatchability, while a dose of 0.9 mg/kg-BW/day had adverse effects on reproductive indices (Sample et al., 1996). The 0.45 mg/kg-BW/day dose is considered a chronic NOAEL, while the 0.9 mg/kg-BW/day dose is considered a chronic LOAEL. These two studies, one using inorganic mercury (mercuric chloride) and one using MeHg (methylmercury dicyandiamide) form the basis of the NOAEL and LOAEL values developed for avian dietary exposures to mercury in SWMU 2 surface soil (see Section 2.5.4).

Finally, mercury in SWMU 2 open water sediment (i.e. Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of mercury ingestion by mammals. A 93-day study using mink indicated that a dose of 0.025 mg/kg-BW/day (administered orally as methyl mercury chloride) caused mortality, weight loss, and behavioral abnormalities (Wobeser et al., 1976 as referenced in Sample et al., 1996). This dose was considered a chronic LOAEL. No adverse effects were observed at a dose of 0.015 mg/kg-BW/day; therefore, this dose is considered a chronic NOAEL. A second study using mink (6-month reproductive study with mercuric chloride) indicated that a dose of 1.0 mg/kg-BW/day (oral in diet) had no effect on fertility and kit survival (Aulerich et al., 1974 as referenced in Sample et al., 1996). This dose is considered a chronic NOAEL. A chronic LOAEL of 10 mg/kg-BW/day was estimated by applying a factor of ten (10) to the chronic NOAEL value (Sample et al., 1996). These two studies, one using inorganic mercury (mercuric chloride) and one using MeHg (methyl mercury chloride) form the basis of the NOAEL and LOAEL values developed for West Indian manatee dietary exposures to mercury in SWMU 2 open water sediment (see Section 2.5.4).

2.4.1.7 Selenium

Selenium is a naturally occurring, non-metal element commonly found in rocks and soil. Four stable valence states of selenium are found naturally, elemental (Se^0), selenides (Se^{-2}), alkali selenites (Se^{+4}), and selenates (Se^{+6}). Elemental selenium and selenides are insoluble, while the selenites and selenates are water soluble (ATSDR, 2003). Commercial and industrial uses include use as a nutritional supplement, in the glass industry, and as a component of paints, inks, rubber, pigments, pharmaceuticals, pesticides, and fungicides. In the environment, selenium is not often found in the pure form. Important factors regulating the form of selenium include pH, redox potential, and the

presence of metal oxides. Much of the selenium in rocks is combined with sulfide minerals or with silver, copper, lead, and nickel minerals (Irwin et al., 1998). Selenium will readily combine with these and other metals directly or in solution and reacts with oxygen to form stable selenium dioxide. Within surface waters, the salts of selenic and selenious acids are prevalent. Depending on the pH of the surface water body, selenium compounds can be highly soluble and do not adsorb to sedimentary particles. Within sediments, organic selenides and selenium oxide are the dominant forms. Natural transport properties include weathering of rock material, volatilization by plants and animals, and volcanic activity. The principle release mechanism of selenium to the environment, however, is coal combustion. Though generally stable in soils, soluble selenium compounds in agricultural fields can be transported from the field in irrigation and drainage waters. Oxidation state, which is dependent upon pH, redox potential, and biological activity, is the principal factor governing the behavior of selenium in the environment. Bacterial and fungal action produces methylselenium (MeSe) and other volatile, organic selenium compounds. In sediments, especially in acidic, reducing, organic-rich environments, selenium forms strong metal selenides complexes which sorb to sediment particles and are relatively immobile and stable (Irwin et al., 1998). Selenium, like mercury, interacts readily with sulphur. Synergistic and antagonistic interactions with mercury have been noted for selenium (Irwin et al., 1998).

Inorganic selenites and selenates, which are more commonly found in alkaline and oxidizing environments, are more bioavailable as they are water soluble (Purkerson et al., 2003). They are readily taken up by plants and converted to various organic compounds (ATSDR, 2003). This uptake is regulated by soil type, pH, organic material, redox potential, and total selenium concentrations. Selenites have been shown to be more concentrated in algae and benthic invertebrates, while equal proportions of the two forms have been measured in fish (ATSDR, 2003). Selenium is identified as a weakly bioaccumulative chemical; however, accumulation is dependent on trophic levels and species (Purkerson et al., 2003). As selenium is also an essential nutrient, it is metabolized by animal species and readily eliminated (Maher et al., 2004). The relative toxicity of selenium compounds has been identified as hydrogen selenides ~ dietary selenomethionine > selenites ~ water selenomethionine > selenate > elemental selenium > metal selenides ~ methylated selenium compounds (Irwin et al., 1998). Chatterjee et al. (2001) investigated selenium concentrations in seagrass species in India. Seasonal variations were noted and total selenium concentrations were found to be greater in roots (0.21 microgram per kilogram [$\mu\text{g/kg}$]-dry weight) than in stems (0.17 $\mu\text{g/kg}$ -dry weight) and leaves (0.11 $\mu\text{g/kg}$ -dry weight).

Selenium sensitivity is dependent upon species, life stage, nutritional status, and health of individual organisms (Irwin et al., 1998). Younger animals and those consuming low-protein diets appear to be impacted more. Very high amounts of selenium can result in reproductive and survivorship effects in invertebrates, birds, and mammals. Exposure to high levels of selenium compounds caused malformations in birds, but selenium has not been shown to cause birth defects in mammals (ATSDR, 2003). Reproductive impacts have been identified concurrently with no impact on adult survivorship in fish (Irwin et al., 1998). Seed germination and growth inhibition has been noted in plants, yet selenium-deficient soils have also been identified.

Based on the SERA and Step 3a of the BERA (Baker, 2006a), selenium in SWMU 2 open water sediment (i.e., Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of selenium ingestion by mammals. A 37-day study using pigs investigated the effects of selenium on growth (Mahan and Moxon, 1984 as cited in USEPA, 2007b). A dose of 0.143 mg/kg-BW/day (oral in diet) had no effect on body weight. This dose, selected by the USEPA as the TRV for mammalian ecological SSL development, represents the highest bounded NOAEL below the lowest bounded LOAEL for

reproduction, growth, or survival (USEPA, 2007b). A reduction in growth occurred at a dose of 0.215 mg/kg-BW/day. This dose is considered a chronic LOAEL. The study by Mahan and Moxon (1984) forms the basis of the NOAEL (0.143 mg/kg-BW/day) and LOAEL (0.215 mg/kg-BW/day) developed for West Indian manatee dietary exposures to selenium in SWMU 2 sediment (see Section 2.5.4).

2.4.1.8 Zinc

Zinc is an element commonly found in the Earth's crust. It is released to the environment from both natural and anthropogenic sources. The primary anthropogenic sources of zinc in the environment are related to mining and metallurgic operations involving zinc and use of commercial products containing zinc (ATSDR, 2005c).

Zinc occurs in the environment mainly in the +2 oxidation state (ATSDR, 2005c). Zinc sorbs strongly onto soil particles. Mobilization in soils depends on the water solubility of the speciated forms of the compound, as well as soil cation exchange capacity, pH, and redox potential. At pH values below 7, pH and solubility of zinc are inversely related (i.e., decreased pH results in increased solubility, and thus, increased potential for mobility). Low soil cation exchange capacity and oxidizing conditions also increase the mobility of zinc. As pH increases over 7, solubility decreases and zinc absorption to soil increases. Relatively little land-disposed zinc at waste sites is in the soluble form; therefore, mobility is limited by a slow rate of dissolution (ATSDR, 2005c). Consequently, movement toward groundwater is expected to be slow unless zinc is applied to soil in soluble form or accompanied by corrosive substances (i.e., mine tailings). Plants and animals may bioaccumulate zinc, but biomagnification in terrestrial food chains has not been observed (ATSDR, 2005c).

Zinc can occur in both suspended and dissolved forms in surface water. Dissolved zinc may occur as the free (hydrated) zinc ion or as dissolved complexes and compounds with varying degrees of stability. Water hardness, pH, and metal speciation are important factors in controlling the water column concentration of zinc. Zinc partitions to sediments or suspended solids in surface waters through sorption onto hydrous iron and manganese oxides, clay minerals, and organic material, resulting in the enrichment of zinc in suspended and bed sediments. The bioavailability of zinc in sediments appears to be controlled by the AVS concentration (Berry et al., 1996, and Sibley et al., 1996). Zinc is an essential micronutrient and uptake in most aquatic organisms appears to be independent of environmental concentrations (MacDonald, 1994). It has been found to bioaccumulate in some organisms, though there is no evidence of biomagnification (Jaagumagi, 1990).

Based on the SERA and Step 3a of the BERA (Baker, 2006a), zinc in SWMU 2 surface and subsurface soil has the potential to impact terrestrial plants and invertebrates. Available literature-based toxicological benchmarks for terrestrial plants and invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3b of the BERA.

- 50 mg/kg: Toxicological threshold for terrestrial plants (Efroymson et al., 1997a)
- 120 mg/kg: Ecological SSL for soil invertebrates (USEPA, 2007c)
- 160 mg/kg: Ecological SSL for terrestrial plants (USEPA, 2007c)

- 200 mg/kg: Toxicological threshold for earthworms (Efroymson et al., 1997b)

Zinc in SWMU 2 estuarine wetland sediment also has the potential to impact aquatic invertebrates (i.e., benthic macroinvertebrates). Available literature-based marine/estuarine toxicological benchmarks for aquatic invertebrates are listed below in their order of increasing concentration. The lowest of the listed toxicological benchmarks was used in Step 2 of the SERA and Step 3b of the BERA.

- 124 mg/kg: TEL marine sediment quality guideline (MacDonald, 1994)
- 150 mg/kg: ER-L marine and estuarine sediment quality guideline (Long et al., 1995)
- 271 mg/kg: PEL marine sediment quality guideline (MacDonald, 1994)
- 410 mg/kg: ER-M marine and estuarine sediment quality guideline (Long et al., 1995)
- 410 mg/kg: AET marine sediment quality guideline (Buchman, 1999)

In addition to terrestrial and aquatic invertebrates, zinc in SWMU 2 surface and subsurface soil has the potential to impact terrestrial avian herbivores and omnivores via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of zinc ingestion by birds. The USEPA (2007c) derived a TRV in accordance with procedures presented in the ecological SSL guidance (USEPA, 2003). The TRV (66.1 mg/kg-BW/day), derived by calculating the geometric mean of literature-based NOAEL values for growth and reproduction endpoints, was used as the chronic NOAEL value for terrestrial avian omnivore and herbivore dietary exposures to zinc in SWMU 2 surface and subsurface soil (see Section 2.5.4). A chronic LOAEL for terrestrial avian omnivore and herbivore dietary exposures (171 mg/kg-BW/day) was derived by calculating the geometric mean of all literature-based LOAEL values listed in USEPA (2007c) for growth and reproduction.

Finally, the SERA and Step 3a of the BERA (Baker, 2006a) indicated that zinc in SWMU 2 open water sediment (i.e., Ensenada Honda sediment) has the potential to impact the West Indian manatee via dietary (food web) exposures. A literature search, conducted as part of the SERA and Step 3a of the BERA, identified studies that have investigated the toxicological effects of zinc ingestion by mammals. USEPA (2007c) derived a mammalian TRV in accordance with procedures presented in the ecological SSL guidance (USEPA, 2003). The TRV (75.4 mg/kg-BW/day) was derived by calculating the geometric mean of literature-based NOAEL values for growth and reproduction endpoints. As discussed in Section 2.5.4, ingestion-based HQ values for the West Indian manatee were calculated by dividing maximum dietary intakes by literature-based NOAEL and LOAEL values adjusted to reflect differences in body weights between mammalian test species and the West Indian manatee. Because the TRV used by the USEPA (2007c) to derive a mammalian ecological SSL for zinc is a geometric mean of several literature-based NOAEL values, an adjustment to reflect differences in body weights between a test species and the West Indian manatee could not be performed. Therefore, a chronic NOAEL and LOAEL value based on a single test species was identified from the list of studies used by the USEPA to develop the mammalian ecological SSL for zinc. The values selected (NOAEL of 8.23 mg/kg-BW/day and LOAEL of 82.3 mg/kg-BW/day) came from a study that investigated the effect of zinc on offspring development in pigs (Hill et al., 1983). The NOAEL value from this study represents the minimum NOAEL for reproduction cited by the USEPA (2007c).

2.4.2 Transport and Exposure Pathways

A transport pathway describes the mechanisms whereby chemicals may be transported from a source of contamination to ecologically relevant media. An exposure pathway links a source of contamination with one or more receptors through exposure to one or more media. Exposure, and thus potential risk, can only occur if each of the following conditions is present (USEPA, 1998):

- A source of contamination must be present.
- Release and transport mechanisms must be available to move the contaminants from the source to an exposure point.
- An exposure point must exist where ecological receptors could contact the affected media.
- An exposure route must exist whereby the contaminant can be taken up by ecological receptors.

2.4.2.1 Sources and Transport Mechanisms

The disposal areas at SWMU 2 represent potential source areas for the release of chemicals to abiotic media (i.e., surface and subsurface soil). Contaminated surface and subsurface soil also represent potential source areas for the release of chemicals to groundwater and/or downgradient surface soil, surface water, and sediment. The primary mechanisms for contaminant transport at SWMU 2 are believed to include the following (Baker, 2006a):

- Overland transport of chemicals with surface soil via surface runoff to downgradient surface soil and estuarine wetland sediment.
- Leaching of chemicals from surface soil and/or subsurface soil by infiltrating precipitation and transport with groundwater to estuarine wetland sediment and Ensenada Honda surface water and sediment.
- Uptake by biota from surface soil, subsurface soil, surface water, and sediment, and trophic transfer to upper trophic level receptors.

2.4.2.2 Exposure Points and Routes

Based upon the results of Steps 3a of the Navy ERA process, the following key exposure pathways were identified for evaluation in the BERA (Baker, 2006a):

- Dermal and ingestion exposures by terrestrial invertebrates to antimony, copper, lead, mercury, and zinc in surface and subsurface soil.
- Root uptake exposures by terrestrial plants to antimony, copper, lead, mercury, and zinc in surface and subsurface soil.
- Food web-based exposures by upper trophic level terrestrial avian herbivores to lead, mercury, and zinc in surface soil and copper, lead, and zinc in subsurface soil.

- Food web-based exposures by upper trophic level terrestrial avian omnivores to lead, mercury, and zinc in surface soil and copper, lead, and zinc in subsurface soil.
- Food web-based exposures by amphibians and reptiles to lead, mercury, and zinc in surface soil and copper, lead and zinc in subsurface soil (potential impacts to terrestrial amphibians and reptiles were assessed qualitatively in the SERA and Step 3a of the BERA through the use of surrogate receptors [i.e., upper trophic level avian receptors]).
- Dermal and ingestion exposures by aquatic invertebrates (i.e., benthic invertebrates) to copper, lead, and zinc in estuarine wetland sediment.
- Food web-based exposures by upper trophic level aquatic avian invertivores to lead and mercury in estuarine wetland sediment.
- Food web-based exposures by upper trophic level mammalian herbivores (i.e., West Indian manatee) to arsenic, cadmium, copper, mercury, lead, selenium, and zinc in Ensenada Honda sediment.

An ninth exposure pathway identified in Step 3a of the BERA requiring additional evaluation was exposures by upper trophic level aquatic reptiles (i.e., sea turtles) to chemicals in Ensenada Honda sediment. Four species of sea turtle potentially inhabit or seasonally visit the coastal waters adjacent to NAPR: green, hawksbill, leatherback, and loggerhead (Geo-Marine, Inc., 2005). Based on the paucity of data concerning the toxicological effects of chemicals for reptiles, a quantitative evaluation of the potential for risk to these species was not performed in Steps 2 of the SERA or Step 3a of the BERA (Baker, 2006a). In lieu of a quantitative evaluation, an examination of the life history information for sea turtles potentially inhabiting or seasonally visiting the coastal waters adjacent to NAPR (i.e. green, hawksbill, leatherback, and loggerhead sea turtles) was performed. In addition, available sea turtle habitat at SWMU 2 was investigated to determine whether potential exposure points and routes exist whereby contaminants may be encountered and subsequently taken up by aquatic reptiles. The results of the qualitative evaluation, presented in the Final Steps 3b and 4 Report (Baker, 2007) concluded that a potentially complete exposure pathway exists for green sea turtles based on the absolute presence of available forage material (in the form of seagrass). However, based on an examination of life history information (e.g., home ranges) and the absence of favorable developmental habitat for juvenile green sea turtles, the magnitude and significance of the pathway was considered negligible and no further evaluation of sea turtles at SWMU 2 was recommended.

2.4.3 Assessment Endpoints and Risk Questions

Assessment endpoints are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by contaminants. The assessment endpoints selected in Step 3b of the BERA were:

Terrestrial habitat:

- *Survival growth and reproduction of terrestrial invertebrate communities* – Soil invertebrates promote soil fertility by breaking down organic matter and releasing nutrients. They also improve aeration, drainage, and aggregation of soils, and serve as a forage base for many terrestrial species. The soils at SWMU 2 will support fewer terrestrial avian invertivores if chemical concentrations in soils are limiting the survival, growth, and reproduction of soil invertebrates.

- *Survival, growth, and reproduction of terrestrial avian omnivore populations* – Avian omnivores are susceptible to bioaccumulative chemicals, especially those that may have the potential to biomagnify through terrestrial food webs. The community also serves as a means of population control for its prey items and as a prey base for terrestrial avian carnivores.

Estuarine wetland system:

- *Survival, growth, and reproduction of benthic invertebrate communities* – Benthic invertebrates serve as the prey base for many aquatic and semi-aquatic species. Many also are detritivores, playing an important role in the breakdown of organic matter and release of nutrients. The estuarine wetland system will support fewer avian invertebrates if chemical concentrations in sediment are limiting the survival, growth, or reproduction of benthic macroinvertebrates.
- *Survival, growth, and reproduction of avian invertivore populations* – These receptors are top-level consumers within the estuarine wetland system at SWMU 2 and are susceptible to bioaccumulative chemicals, especially those that have the potential to biomagnify through aquatic food webs. The community also serves as a means of population control for its prey items.

Open water habitat:

- *Survival, growth, and reproduction of West Indian manatees* – West Indian manatees are susceptible to chemicals that may bioaccumulate within their diet of submerged aquatic vegetation. Food web impacts beyond the manatees are not of concern as manatees have no known predators due to a size refuge. Manatees were selected as an assessment endpoint for SWMU 2 based on their known occurrence within the Ensenada Honda (see Figure 2-7) and their Federal status in Puerto Rico (endangered).

Assessment endpoints were not selected for terrestrial amphibians and reptiles. As discussed in the SERA and Step 3a of the BERA (Baker, 2006a), there is a paucity of data concerning the toxicological effects of chemicals for amphibians and reptiles, rendering a quantitative evaluation problematic (USEPA, 2000b and 2003). For the BERA, it was assumed that any terrestrial amphibians and reptiles at SWMU 2 are not exposed to significantly higher concentrations of ecological COCs than the other upper trophic level receptor species selected as assessment endpoints. Therefore, a conclusion of acceptable or unacceptable risk to the upper trophic level terrestrial receptors evaluated in the BERA also will apply to terrestrial amphibians and reptiles. For terrestrial reptiles, this approach is consistent with USEPA Region III guidance (USEPA, 2006; available at <http://www.epa.gov/reg3hwmd/risk/eco/index.htm>), which states that “As a general rule in Region 3, impacts to reptiles do not have to be considered as an assessment endpoint in the screening level ERA. However, the screening ERA would need to state that impacts to reptiles are being assessed qualitatively through the use of surrogate receptors. An exception to this rule is when a threatened or endangered reptile has been identified as a potential receptor on the site. In this situation, it may be appropriate to consider impact on reptiles when identifying assessment endpoints.”

Although antimony, copper, lead, mercury, and zinc were identified as ecological COCs for terrestrial plant communities at SWMU 2, an assessment endpoint was not selected for terrestrial plants. During the habitat characterization conducted at SWMU 2 (Geo-Marine Inc., 2000; see Appendix A), the field biologists made visual observations to characterize the health of the terrestrial plant community. Indications of an altered plant community used in the assessment included the presence of chlorotic

leaves (pale foliage due to reduced chlorophyll content), epinasty (deformities of leaves and stems), patches of altered plant growth, absence of plants (bare ground), and changes in species composition. To determine the presence of an altered plant community, a nearby representative site was selected as a control. The control was chosen in order to be representative of the plant community present at SWMU 2 (upland coastal forest community). Specifically, the control exhibited similar topography, soils, and position within the landscape (i.e., located between a paved road and a mangrove community). Field observations concluded that the terrestrial plant community at SWMU 2 is growing healthy and vigorously, with no evidence of stress. Furthermore, there are no noticeable differences in plant community species composition between the control and SWMU 2. Though all potential impacts on the upland vegetative communities cannot be quantified by visual inspections alone, potential risks to terrestrial plants are considered acceptable based on observations made during the habitat characterization. Therefore, terrestrial plants were excluded from further consideration in Step 3b of the BERA.

Lead, mercury, and zinc in surface soil and copper, lead, and zinc in subsurface soil were identified as ecological COCs for both terrestrial avian omnivore and herbivore food web exposures at SWMU 2. However, an assessment endpoint was not selected for avian herbivore food-web exposures. This decision was based on the Step 3a risk calculations (Baker, 2006a), which showed that avian omnivores represent the more exposed feeding guild and are at greater risk to lead, mercury and zinc in surface soil and copper, lead, and zinc in subsurface soil:

Surface soil

- Lead NOAEL-based HQ values: 6.79 for terrestrial avian omnivores; 3.75 for terrestrial avian herbivores
- Mercury NOAEL-based HQ values: 8.82 for terrestrial avian omnivores; 6.77 for terrestrial avian herbivores
- Zinc NOAEL-based HQ values: 3.27 for terrestrial avian omnivores; 1.33 for terrestrial avian herbivores

Subsurface soil

- Copper NOAEL-based HQ values: 0.38 for terrestrial avian omnivores and 0.29 for terrestrial avian herbivores (copper was identified as an ecological COC in step 3a of the BERA based on the magnitude of the maximum detected concentration [5,850 mg/kg])
- Lead NOAEL-based HQ values: 11.19 for terrestrial avian omnivores; 6.19 for terrestrial avian herbivores
- Zinc NOAEL-based HQ values: 5.23 for terrestrial avian omnivores; 2.12 for terrestrial avian herbivores

Because terrestrial avian omnivores are at greater risk to lead, mercury, and zinc in surface soil and copper, lead, and zinc in subsurface soil, a conclusion of acceptable risk to terrestrial avian omnivores in the BERA also would apply to terrestrial avian herbivores. If the BERA concludes that potential risks to terrestrial avian omnivores from one or more of these metals are not acceptable, corrective action objectives (CAOs) derived for the protection of terrestrial avian omnivores also would be protective of terrestrial avian herbivores.

Risk questions ask how the assessment endpoints could be affected by site-related conditions. Risk questions also clarify and articulate relationships that are possible through consideration of available data, information from the scientific literature, and the best professional judgment of risk assessors. Finally, they can form the basis for developing a study design for subsequent steps of the ERA process. The risk questions associated with the assessment endpoints identified above are listed below.

- Are antimony, copper, lead, mercury, and zinc concentrations in SWMU 2 surface and subsurface soil high enough to impair the survival, growth, or reproduction of terrestrial invertebrate communities?
- Are lead, mercury, and zinc concentrations in SWMU 2 surface soil and copper, lead, and zinc concentrations in SWMU 2 subsurface soil high enough to impair the survival, growth, or reproduction of terrestrial avian omnivore populations?
- Are copper, lead, and zinc concentrations in SWMU 2 estuarine wetland sediment high enough to impair the survival, growth, or reproduction of aquatic invertebrate communities?
- Are lead and mercury concentrations in SWMU 2 estuarine wetland sediment high enough to impair the survival, growth, or reproduction of avian invertivore consumer populations?
- Are arsenic, cadmium, copper, lead, mercury, selenium, and zinc concentrations in SWMU 2 open water sediment (i.e., Ensenada Honda sediment) high enough to adversely affect the survival, growth, or reproduction of West Indian manatees?

2.5 BERA Study Design/Data Quality Objectives

Step 4 of the ERA process (Study Design/Data Quality Objectives) established the measurement endpoints, the study design, DQOs, and data analysis methods for the additional site investigations necessary to complete the ERA (USEPA, 1997a). The components of the Step 4 investigations provide multiple lines of evidence on which to evaluate potential ecological risks or existing ecological impacts from exposures to contaminants in surface soil, subsurface soil, estuarine wetland sediment, and open water sediment at SWMU 2. These lines of evidence are site-specific, direct measures of potential ecological effects and are thus preferable to the comparison of chemical concentrations to conservative, non-site-specific screening values, and other conservative assumptions, which form the basis for SERAs. The use of multiple lines of evidence reduces the dependence on any one type of data and thus reduces the uncertainty of the analysis, allowing for more confident decisions to be made about the need for, and extent of, corrective actions.

2.5.1 Measurement Endpoints

Measurement endpoints are measures of biological effects (e.g., laboratory toxicity test results) that are related to each respective assessment endpoint (USEPA, 1997a). As outlined in Section 2.4.3, assessment endpoints identified by the refined conceptual model are the survival, growth, and reproduction of terrestrial invertebrate communities, terrestrial avian omnivore populations, estuarine wetland benthic invertebrate communities, estuarine wetland avian invertivore populations, and West Indian manatees. Measurement endpoints related to these assessment endpoints, which guided the design of the field investigation, are as follows:

Survival, growth, and reproduction of terrestrial invertebrate communities:

- Comparison of antimony, copper, lead, mercury, and zinc concentrations in surface and subsurface soil with soil screening values and literature-based effect levels.
- Comparison of results of 28-day laboratory toxicity tests (survival, growth, and reproduction) with the earthworm *Eisenia fetida*, using site and reference soil.
- Existence of significant correlations between laboratory toxicity test results and concentrations of antimony, copper, lead, mercury, and zinc in soil or other chemical/physical characteristics of the tested soil (e.g., total organic carbon [TOC], pH, and grain size distributions).

Survival, growth, and reproduction of terrestrial avian omnivore populations:

- Comparison of modeled dietary intakes of copper, lead, mercury, and zinc using mean measured tissue concentrations in earthworms maintained in site soil during toxicity testing with ingestion-based TRVs.

Survival, growth, and reproduction of estuarine wetland benthic invertebrate communities:

- Comparisons of copper, lead, and zinc concentrations in sediment with sediment screening values and literature-based effect levels.
- Comparison of sediment SEM (i.e., cadmium, copper, lead, nickel, silver, and zinc) sediment concentrations with sediment AVS concentrations.
- Comparison of results of 28-day sediment laboratory toxicity tests (survival, growth, and reproduction) with the burrowing amphipod *Leptocheirus plumulosus* and 20-day sediment laboratory toxicity tests (survival and growth) with the polychaete *Neanthes arenaceodentata*, using site and reference sediment.
- Existence of significant correlations between laboratory toxicity test results and concentrations of copper, lead, and zinc in sediment or other chemical/physical characteristics of the tested sediment (e.g., TOC, pH, and grain size distributions).

Survival, growth, and reproduction of estuarine wetland avian invertivores:

- Comparison of modeled dietary intakes of lead and mercury using measured tissue concentrations in fiddler crabs (*Uca* spp.) collected from the estuarine wetland habitat at SWMU 2 with ingestion-based TRVs.

Survival, growth, and reproduction of herbivorous West Indian manatees:

- Comparison of modeled dietary intakes of arsenic, cadmium, copper, lead, mercury, selenium, and zinc using measured tissue concentrations in seagrass collected from the open water habitat at SWMU 2 with ingestion-based TRVs.

2.5.2 BERA Study Design

In order to address the measurement endpoints listed in Section 2.5.1, the following BERA study design was developed and discussed within the Field Sampling and Analysis Plan (FSAP) section of the Final Steps 3b and 4 Report (Baker, 2007).

- Collection of soil (surface and subsurface soil), estuarine wetland sediment, and open water sediment for laboratory-based analytical testing. Both surface and subsurface soil was collected at SWMU 2 because maximum concentrations for three metals identified as ecological COCs for terrestrial invertebrate direct contact exposures in Step 3a of the BERA occurred in subsurface soil (copper: 919J mg/kg in surface soil and 5,850 mg/kg in surface soil; lead: 4,760 mg/kg in surface soil and 5,850J mg/kg; zinc: 1,140 mg/kg in surface soil and 3,350 mg/kg in subsurface soil [Baker, 2006a]).
- Collection of soil for laboratory-based toxicological testing using the earthworm *Eisenia fetida*. This species was selected as the test organism for evaluating the toxicity and bioavailability of antimony, copper, lead, mercury, and zinc in soil to terrestrial invertebrates for the reasons listed below:
 - o The terrestrial invertebrate fauna of Puerto Rico includes eighteen endemic earthworm species (Blakemore, 2005).
 - o A test method has been developed by the American Society of Testing and Materials [ASTM], 2006a using *Eisenia fetida* with two sublethal endpoints (i.e., growth and reproduction), allowing for population-level risk evaluations on terrestrial invertebrates (ASTM Standard E 1676-04: *Standard Guide for Conducting Soil Toxicity or Bioaccumulation Tests with the Lumbricad Earthworm Eisenia Fetida and the Enchytraeid Potworm Enchytraeus albidus* [ASTM, 2006a]).
- Collection of earthworm (*Eisenia fetida*) tissue maintained in SWMU 2 soil during toxicity testing for laboratory-based analytical testing of antimony, copper, lead, mercury, and zinc. Earthworms are deemed an appropriate species for evaluating bioaccumulation and subsequent food web transfer based on their burrowing activities and feeding habits which expose them to soil contaminants. The collection of earthworm tissue is preferable; however, a sufficient biomass for analytical testing was not encountered during the BERA field investigation.
- Collection of estuarine wetland sediment for laboratory-based toxicological testing using the amphipod *Leptocheirus plumulosus* and the polychaete *Neanthes arenaceodentata*. These species were selected as test organisms for evaluating the toxicity and bioavailability of copper, lead, and zinc in estuarine wetland sediment to benthic invertebrates for the reasons listed below:
 - o *Leptocheirus plumulosus* and *Neanthes arenaceodentata* are infaunal species intimately associated with sediment due to their burrowing habits and sediment ingesting nature (USEPA, 2001a, ASTM, 2006b, and California Environmental Protection Agency [CEPA], 2004).
 - o *Leptocheirus plumulosus* and *Neanthes arenaceodentata* are tolerant of a wide range of TOC, salinity, and grain size distributions (USEPA, 2001a and CEPA, 2004).

- o *Leptocheirus plumulosus* and *Neanthes arenaceodentata* have a high tolerance for ammonia, a naturally occurring compound in marine sediments that results from the degradation of organic debris (USEPA, 2001a and CEPA, 2004).
- o A chronic test method has been developed by the USEPA (2001a) using *Leptocheirus plumulosus* with two sublethal endpoints (i.e., growth and reproduction) and a chronic test method has been developed by ASTM (2006b) for *Neanthes arenaceodentata* with a single sublethal endpoint (growth), allowing for population-level risk evaluations on benthic invertebrates (EPA 600/R-01/020: *Method for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-Associated Contaminants with the Amphipod Leptocheirus plumulosus* [USEPA, 2001a]; ASTM Standard E 1562-94: *Standard Guide for Conducting Acute, Chronic, and Life-Cycle Aquatic Toxicity Tests with Polychaetous Annelids* [ASTM, 2006b]);
- Collection of fiddler crab (*Uca* spp.) tissue samples from estuarine wetland habitat at SWMU 2 for laboratory-based analytical testing of lead and mercury. Fiddler crabs are deemed an appropriate species for evaluating bioaccumulation and subsequent food web transfer of ecological COCs to avian invertivores based on their burrowing activities (which expose them to sediment contaminants), feeding habits, sedentary behavior, and presence in large numbers within estuarine wetland systems at NAPR.
- Collection of turtle grass tissue samples from the open water portion of SWMU 2 for laboratory-based analytical testing of arsenic, cadmium, copper, lead, mercury, selenium, and zinc. Turtle grass was selected to evaluate West Indian manatee food web exposures since seagrass meadows within the Ensenada Honda are dominated by a nearly continuous cover of turtle grass (Reid et al., 2001). Furthermore, though manatees will forage on manatee grass, shoal grass, and green algae, they preferentially feed on turtle grass, even when it is not the dominant species. This preference is the same across age classes and genders (Mignucci-Giannoni and Beck, 1998).

Foraging studies demonstrate that manatees in NAPR waters feed via two primary strategies: (1) selective grazing of above ground shoots and stems only; or (2) rooting behavior and subsequent feeding on the entire plant, including roots and rhizomes (Geo-Marine Inc., 2005, Reid et al., 2001, and Mignucci-Giannoni and Beck, 1998). Selective above ground feeding behavior is characteristic of manatees observed in firm bottom habitats, where encrusting algae, coarser sediments, and/or more cohesive sediments are present (Reid et al., 2001). Although coarse and cohesive sediments are present within the open water portions of SWMU 2 and literature-based information indicates that West Indian manatees exhibit selective above ground feeding behavior within the Ensenada Honda (Reid et al., 2001), both above ground and whole-plant tissue samples were collected for laboratory-based analytical testing as a measure of conservatism.

- Collection of sediment samples co-located with the above ground and whole-plant turtle grass tissue samples for laboratory-based analytical testing of arsenic, cadmium, copper, lead, mercury, selenium, and zinc. These data were utilized to determine if turtle grass samples were collected from areas that are representative of sediment concentrations observed within the Ensenada Honda during previous field investigations (2003 and 2004 additional data collection field investigations [Baker, 2006a]).

- Identification of suitable upland, estuarine wetland, and open water reference areas, and the collection of soil, sediment, turtle grass tissue, and/or fiddler crab tissue samples at these locations for laboratory-based analytical and/or toxicological testing.

2.5.3 Data Quality Objectives

The USEPA defines the DQO process as a “*strategic approach based on the scientific method that is used to prepare for a data collection activity. It provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, where to collect samples, the tolerance level of decision errors for the study, and how many samples to collect*” (Barnthouse and Suter, 1996).

The purpose of the DQO process is to ensure that the type, quantity, and quality of data used in the decision-making process are appropriate for estimating potential ecological risks. By employing the DQO process, data requirements and error levels acceptable to the investigation were defined prior to the collection of data. The DQO process is composed of seven steps (USEPA, 2000c and 2000d). These seven steps, as well as the general DQO process that applied to the BERA for SWMU 2 were developed in the Final Steps 3b and 4 Report (Baker, 2007) and are outlined below:

- Step 1 - State the problem: Define the degree and spatial extent of any ecological risks from exposure to site-related chemicals in SWMU 2 soil, estuarine wetland sediment, and Ensenada Honda sediment.
- Step 2 - Identify the decision: Is there evidence of unacceptable risk to ecological receptors? Are there sufficient data on which to base this decision?
- Step 3 - Identify the inputs: Analytical chemistry data from relevant media (soil, estuarine wetland sediment, Ensenada Honda sediment, earthworm tissue, fiddler crab tissue, and turtle grass tissue), physical/chemical characteristics of exposure media, and toxicological testing.
- Step 4 - Define the boundaries of the study: Upland, estuarine wetland, and open water portions of SWMU 2.
- Step 5 - Develop a decision rule: Based upon the results of multiple lines of evidence for which data are available, including (1) comparison of measured media concentrations to applicable risk-based screening values; (2) refined food web modeling using measured tissue concentrations; and (3) toxicological testing.
- Step 6 - Specify tolerable limits on decision errors: Acceptable data requirements and error levels associated with the field and analytical portions of this investigation are presented in the Master Plans (Baker, 1995), including the Master Project Management Plan (PMP), the Master Data Collection Quality Assurance Plan (DCQAP), Data Management Plan (DMP), and Master Health and Safety Plan (HASP). Acceptable data requirements and error levels associated with the *Eisenia fetida*, *Leptocheirus plumulosus*, and *Neanthes arenaceodentata* laboratory-based toxicity tests (i.e., test conditions, data, and data interpretation) have been established by USEPA (2001a) and ASTM (2006a and 2006b). Specific data requirements and error levels identified by the toxicity testing laboratory are included in their scope of work (SOW), included as Appendix B.

- Step 7 - Optimize the design for obtaining data: Compile and evaluate information and data to focus sampling efforts. Inherently optimized through the iterative nature of the 8-step ERA process.

2.5.4 Data Evaluation and Interpretation

The specific lines of evidence employed in this investigation and the methods of evaluation developed in the Final Steps 3b and 4 Report (Baker, 2007) are identified and discussed below.

Survival, growth, and reproduction of terrestrial invertebrate communities:

- *Comparison of the spatial and statistical distributions of antimony, copper, lead, mercury, and zinc concentrations in soil to appropriate literature-based toxicological thresholds* – 95 percent upper confidence limit (UCL) of the mean concentrations were calculated for a combined soil data set consisting of analytical data used in Step 2 and Step 3a of the ERA process (see Table 2-5 for surface soil and Table 2-6 for subsurface soil) and analytical data generated as part of the BERA field investigation (see Section 4.2.1). A combined soil data set using all available analytical data from the 0.0 to 2.0-foot depth interval was used since SWMU 2 surface and subsurface soil samples have not been collected from consistent depth intervals during the various field investigations. For example, surface soil was sampled from the 0.0 to 0.5-foot depth interval during the SI. However, during the 1996 RFI and 2003 and 2004 additional data collection investigations, surface soil was sampled from the 0.0 to 1.0-foot depth interval. In the case of subsurface soil, samples collected during the SI were taken from the 0.5 to 1.5-foot depth interval, while samples collected during the 1996 RFI and 2003 and 2004 additional data collection investigations were taken from the 1.0 to 2.0-foot depth interval.

Ninety-five percent UCL of the mean soil concentrations were calculated using USEPA ProUCL Version 4.0.010 software (USEPA, 2007e and 2007f). Ninety-five percent UCL of the mean concentrations calculated from the combined soil data set were used to derive risk estimates for using the HQ method. For a given ecological COC, HQs were calculated by dividing 95 percent UCL of the mean surface soil concentrations by the corresponding soil screening value. HQ values greater than 1.0 indicate the potential for unacceptable risk to terrestrial invertebrate communities. It is noted that the magnitude of detections above soil screening values was considered when evaluating risk estimates (Parker et al., 2003). This was accomplished by calculating HQ values based on maximum concentrations. This consideration ensures that potential effects of soil “hot spots” are not diluted by calculating 95 percent UCL of the mean concentrations. The spatial extent of detections above the soil screening values also was considered when evaluating risk estimates based on 95 percent UCL of the mean concentrations.

The antimony, copper, lead, mercury, and zinc soil screening values selected for this line of evidence are listed below. Ecological SSLs based on terrestrial invertebrates (documentation is available at <http://www.epa.gov/ecotox/ecossl/>) were preferentially selected as soil screening values. Earthworm-based toxicological thresholds developed by Efroymson et al. (1997b) were selected as soil screening values for those chemicals lacking an invertebrate-based ecological SSL.

- o Antimony: 78 mg/kg – Eco-SSL for soil invertebrates (USEPA, 2005a)
- o Copper: 80 mg/kg – Eco-SSL for soil invertebrates (USEPA, 2007a)

- o Lead: 1,700 mg/kg – Eco-SSL for soil invertebrates (USEPA 2005d).
- o Mercury: 0.1 mg/kg – Toxicological benchmark for earthworms (Efroymson et al., 1997b)
- o Zinc: 120 mg/kg – Eco-SSL for soil invertebrates (USEPA, 2007c)

The soil screening values listed above for antimony, copper, lead, and zinc were not used in the Step 2 screening-level risk calculation or the Step 3a refinement (Baker, 2006a). The values used for antimony, lead, and zinc (5 mg/kg, 50 mg/kg, and 50 mg/kg, respectively) were literature-based toxicological benchmarks for terrestrial plants (Efroymson et al., 1997a). As discussed in Section 2.4.3, potential risks to terrestrial plants at SWMU 2 are considered acceptable based on observations made during the May 2000 habitat characterization. For this reason, an assessment endpoint was not established for this receptor group in Step 3b of the ERA process. Based on the results of the SERA and Step 3a of the BERA, the assessment endpoints established for the BERA include survival, growth, and/or reproduction of terrestrial invertebrates. Therefore, soil screening values based on terrestrial invertebrates are more appropriate for use in the BERA than soil screening values based on terrestrial plants. Although the screening value established for copper in the SERA was invertebrate-based (50 mg/kg [Efroymson et al., 1997b]), this value was updated to reflect current information from the literature.

- *Comparison of Eisenia fetida survival, growth, and reproduction in SWMU 2 soil to Eisenia fetida survival, growth, and reproduction in reference soil* – Statistical comparisons between site samples and reference samples were performed for each endpoint individually. The tests determined whether organism performance (i.e., *Eisenia fetida* survival, growth, and reproduction) in soil collected at SWMU 2 was significantly different (at $\alpha = 0.05$) than organism performance in soil collected at the reference area.
- *Existence of patterns in Eisenia fetida laboratory toxicity test results with chemical burdens and other chemical/physical characteristics of SWMU 2 soil* – The data were reviewed to determine whether there are relationships between biological responses in the toxicity tests and antimony, copper, lead, mercury, and zinc concentrations in soil. This was accomplished with the use of linear and multiple regressions. Other factors considered in the analyses included soil TOC, pH, and grain size characteristics.

Survival, growth, and reproduction of terrestrial avian omnivore populations:

- *Comparison of 95 percent UCL of the mean terrestrial avian omnivore dietary intakes to literature-based TRVs.* 95 Percent UCL of the mean copper, lead, mercury, and zinc concentrations in earthworm tissue were used in place of modeled earthworm tissue concentrations to estimate dietary intakes for terrestrial avian omnivores. Although antimony was not identified as an ecological COC for terrestrial avian omnivore food web exposures in Step 3a of the ERA process (Baker, 2006a and 2007), dietary intakes were also estimated for this metal using earthworm tissue concentrations (see Section 3.2.3) since the maximum soil concentration for antimony was detected in soil collected during the BERA field investigation. Dietary intakes were estimated using the following formula modified from USEPA (1993):

$$DI_x = \frac{[[\sum_i [(FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)]] [AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg-BW/day)
FIR	=	Mean food ingestion rate (kilograms per day [kg/day], dry weight)
FC_{xi}	=	95 percent UCL of the mean concentration of chemical x in food item i (mg/kg, dry weight)
PDF_i	=	Proportion of diet composed of food item i (unitless, dry weight basis)
SC_x	=	95 percent UCL of the mean concentration of chemical x in soil (mg/kg, dry weight)
PDS	=	Proportion of diet composed of soil (unitless, dry weight basis)
BW	=	mean body weight (kilograms [kg], wet weight)
AUF	=	Area Use Factor (unitless)

The American robin was used as a representative species for terrestrial avian omnivores at SWMU 2. Receptor-specific exposure parameters used for the American robin included a mean food ingestion rate of 0.00383 kg/day-dry weight (Levy and Karasov, 1989) and a mean body weight of 0.0773 kg (USEPA, 1993). Although the American robin is omnivorous, the exposure diet was assumed to be 90.9 percent earthworms and 9.1 percent surface soil (no plant material). Because the food ingestion rate of the American robin varies based on the percentage of plant material and invertebrates in the total diet (the food ingestion rate decreases as the percentage of invertebrates increases [Levy and Karasov, 1989], the food ingestion rate identified above was weighted to reflect the absence of plant material from the total diet. Direct ingestion of drinking water is only considered if the salinity of a drinking water source is less than 15 ppt, the approximate toxic threshold for wildlife receptors (Humphreys, 1988). As discussed in the SERA (Baker, 2006a), no potential drinking water sources are located within or contiguous to SWMU 2. As such, ingestion of surface water does not represent a potential exposure pathway and was not considered in risk calculations for American robin dietary exposures. Finally, it was assumed that the American robin spends 100 percent of its time within the upland portions of SWMU 2 (i.e., an AUF of 1.0 was assumed).

Ingestion-based HQs for the American robin were calculated by dividing dietary intakes by literature-based NOAEL and LOAEL values. In addition to NOAEL- and LOAEL-based risk estimates, HQ values were derived using maximum acceptable toxicant concentrations (MATCs). For a given ecological COC, the MATC (derived by taking the geometric mean of the NOAEL and LOAEL value) represents an estimate of the dose above which adverse ecological effects occur. Test species NOAEL and LOAEL values used in the derivation of antimony, copper, lead, mercury, and zinc HQ values for American robin dietary exposures are summarized in Table 2-14. Sample et al. (1996) consider a scaling factor of 1.0 most appropriate for interspecies extrapolation between birds. Therefore, the NOAEL and LOAEL values summarized in Table 2-14 were not adjusted to reflect differences in body weights between avian test species and avian receptor species. As a measure of conservatism, it was assumed that all mercury in SWMU 2 surface soil is present as MeHg. Therefore, mercury HQ values were derived using the NOAEL and LOAEL value from the study using methylmercury dicyandiamide as the test material.

As discussed in Section 2.2.3.2, SWMU 2 is located within the critical habitat designation for the yellow-shouldered blackbird (federally endangered in Puerto Rico). Aspects of the feeding ecology of the American robin and yellow-shouldered blackbird indicate that the American robin can be protectively used as a surrogate receptor:

- The American robin forages on the ground for soft-bodied invertebrates, whereas the yellow-shouldered black bird is an arboreal feeder that forages within the canopy and sub-canopy of trees (USFWS, 1996a). The invertebrate prey item consumed by the American robin is assumed to be earthworms in the BERA. Because earthworms are in direct contact with soil, they will bioaccumulate soil contaminants at higher concentrations than the arboreal invertebrates consumed by the yellow-shouldered blackbird. Modeled dietary intakes that include earthworm ingestion will result in a conservative estimate of food web exposures for the yellow-shouldered blackbird.
- The diet of the American robin is assumed to include 9.1 percent soil (Levy and Karasov, 1989), whereas soil consumption by the yellow-shouldered blackbird is likely to be negligible based on their arboreal feeding behavior. Modeled dietary intakes that include soil ingestion also will result in a conservative estimate of food web exposures for the yellow-shouldered blackbird.

Because the American robin is being used as a surrogate receptor for the yellow-shouldered blackbird, conclusions regarding the acceptability of risk are based on HQ values derived using NOAEL values (a NOAEL-based HQ value greater than 1.0 indicates the potential for unacceptable risk). Although not considered when determining the acceptability of risk, MATC- and LOAEL-based HQ values for each ecological COC also were derived to provide perspective on the range of potential risks since the NOAELs listed in Table 2-14 are, in part, artifacts of dose selection and do not represent actual threshold effects.

For a given chemical, if an unacceptable risk was indicated by the evaluation, the NOAEL-based HQ value for that chemical was compared to a NOAEL-based HQ value for American robin dietary exposures at the upland reference area. Reference area risk estimates were derived using the procedure presented above. The comparison determined if potential risks presented by ecological COCs in SWMU 2 surface soil exceed potential risks at the reference area.

Survival, growth, and reproduction of estuarine wetland benthic invertebrate communities:

- *Comparison of the spatial and statistical distributions of copper, lead, mercury, and zinc in SWMU 2 estuarine wetland sediment to benthic invertebrate-based toxicological thresholds* – 95 percent UCLs of the mean concentrations were calculated from a combined sediment data set consisting of analytical data used in Step 2 and Step 3a of the ERA process (see Table 2-11) and analytical data generated as part of the BERA field investigation (see Section 4.2.4) using USEPA ProUCL Version 4.00.04 software (USEPA, 2009a and 2009b). 95 percent UCL of the mean concentrations calculated from the combined data set were then used to derive risk estimates using the HQ method. For a given ecological COC, the HQ was calculated by dividing the 95 percent UCL of the mean concentration by the corresponding sediment screening value. HQs greater than 1.0 indicate the potential for unacceptable risk for estuarine wetland benthic invertebrates. It is noted that the magnitude and spatial extent of detections above sediment screening values was considered when evaluating risk estimates based on 95 percent UCL of the mean concentrations (Parker et al., 2003). This was accomplished by calculating HQ values based on maximum concentrations. This

consideration ensures that potential effects of sediment “hot spots” are not diluted by calculating 95 percent UCL of the mean concentrations. The spatial extent of detections above sediment screening values also was considered when evaluating risk estimates based on 95 percent UCL of the mean concentrations. Although mercury was not identified as an ecological COC for benthic invertebrate direct contact exposures in Step 3a of the ERA process (Baker, 2006a and 2007), risk estimates also were derived for this metal (see Section 4.2.4).

The copper, lead, mercury, and zinc sediment screening values selected for this line of evidence are listed below. These sediment screening values were used in Step 2 of the SERA and Step 3a of the BERA.

- o Copper: 18.7 mg/kg – Marine TEL (MacDonald, 1994)
- o Lead: 30.2 mg/kg – Marine TEL (MacDonald, 1994)
- o Mercury: 0.13 mg/kg – Marine TEL (MacDonald, 1994)
- o Zinc: 124 mg/kg – Marine TEL (MacDonald, 1994)
- *Derivation of SEM-to-AVS ratios to assess the bioavailability of bulk copper, lead, and zinc concentrations in SWMU 2 estuarine wetland sediment* – The AVS/SEM model states that if the AVS concentration is greater than the concentration of SEM (cadmium, copper, lead, nickel, silver, and zinc), toxicity will not be observed. That is, if the ratio SEM-to-AVS is greater than 1.0, sufficient AVS is available to bind all the SEM and sediment-associated biota are not likely to be exposed to toxic concentrations of these metals in the sediment pore water. Conversely, if the ratio SEM-to-AVS is less than 1.0, insufficient AVS is present to bind all SEM. The AVS and SEM data were evaluated on a sample by sample basis, allowing for the identification of spatially explicit areas where copper, lead, and zinc are or are not bioavailable to benthic invertebrates.
- *Comparison of *Leptocheirus plumulosus* survival, growth, and reproduction data and *Neanthes arenaceodentata* survival and growth data in SWMU 2 estuarine wetland sediment to *Leptocheirus plumulosus* survival, growth, and reproduction data and *Neanthes arenaceodentata* survival and growth data in reference sediment* – Statistical comparisons between site samples and reference samples were performed for each endpoint individually. The tests determined whether organism performance (i.e. *Leptocheirus plumulosus* survival, growth, and reproduction and *Neanthes arenaceodentata* survival and growth) in estuarine wetland sediment collected from SWMU 2 was significantly different ($\alpha = 0.05$) than organism performance in estuarine wetland sediment collected from the reference area.
- *Existence of patterns in *Leptocheirus plumulosus* and *Neanthes arenaceodentata* laboratory toxicity test results with chemical burdens and other chemical/physical characteristics of estuarine wetland sediment* – The data were reviewed to determine whether there are relationships between biological responses in the toxicity tests and copper, lead, mercury, and zinc concentrations in sediment. This was accomplished with the use of linear and multiple regressions. Other factors considered in the analyses included sediment SEM-to-AVS ratios, ammonia, sulfide, pH, TOC, and grain size characteristics, as well as pore water and overlying water salinity pH, ammonia, and sulfide.

Survival, growth, and reproduction of estuarine wetland avian invertivores:

- *Comparison of 95 percent UCL of the mean dietary intakes for avian invertivores to literature-based toxicity reference values.* 95 percent UCL of the mean lead and mercury concentrations in fiddler crab tissue were used in place of modeled tissue concentrations to estimate dietary intakes for aquatic avian invertivores. Dietary intakes were estimated using the following formula modified from the USEPA (1993):

$$DI_x = \frac{[[\sum_i [(FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)]] [AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg-BW/day)
FIR	=	Mean food ingestion rate (kg/day, dry weight)
FC_{xi}	=	95 percent UCL of the mean concentration of chemical x in food item i (mg/kg, dry weight)
PDF_i	=	Proportion of diet composed of food item i (unitless, dry weight basis)
SC_x	=	95 percent UCL of the mean concentration of chemical x in sediment (mg/kg, dry weight)
PDS	=	Proportion of diet composed of sediment (unitless, dry weight basis)
BW	=	mean body weight (kg, wet weight)
AUF	=	Area Use Factor (unitless)

The spotted sandpiper was used as a representative species for avian invertivores. Receptor-specific exposure parameters used for the spotted sandpiper included a mean food ingestion rate of 0.00804 kg/day-dry weight (allometric equation from Nagy 2001 for all birds) and a mean body weight of 0.0404 kg (Dunning, 1993). The exposure diet was assumed to be 81.9 percent aquatic invertebrates (USEPA, 1993) and 18.1 percent sediment (Beyer et al, 1994). As discussed for the American robin, direct ingestion of drinking water is only considered if the salinity of a drinking water source is less than 15 ppt, the approximate toxic threshold for wildlife receptors (Humphreys, 1988). No potential drinking water sources are located within or contiguous to SWMU 2; therefore, ingestion of surface water does not represent a complete exposure pathway and was not considered in risk calculations for spotted sandpiper dietary exposures. Finally, it was assumed that the spotted sandpiper spends 100 percent of its time within the estuarine wetland portion of SWMU 2 (i.e., an AUF of 1.0 was assumed).

Ingestion-based HQs for the spotted sandpiper were calculated by dividing mean dietary intakes by literature-based NOAEL and LOAEL values. In addition to NOAEL- and LOAEL-based risk estimates, HQ values were derived using MATCs. For a given ecological COC, the MATC was derived by taking the geometric mean of the NOAEL and LOAEL value. Test species NOAEL and LOAEL values used in the derivation of lead and mercury HQ values for spotted sandpiper dietary exposures are summarized in Table 2-14. Sample et al. (1996) consider a scaling factor of 1.0 most appropriate for interspecies extrapolation between birds. Therefore, the NOAEL, MATC, and LOAEL values summarized in Table 2-14 were not adjusted to reflect differences in body weights between avian test species and avian receptor species. As a measure of conservatism, it was assumed that all mercury in SWMU 2 and reference area sediment is present at MeHg. Therefore, mercury HQ values were derived using the NOAEL and LOAEL value from the study using methylmercury

dicyandiamide as the test material. As no threatened or endangered shore birds/wading birds are likely to forage within the estuarine wetland system downgradient from SWMU 2 (see Section 2.2.3.2), conclusions regarding the acceptability of risk to the spotted sandpiper are based on HQ values derived using MATC values (a MATC-based HQ value greater than 1.0 indicates the potential for unacceptable risk). Little weight was given to NOAEL-based HQ values since the NOAEL values listed in Table 2-14 do not represent threshold affects.

For a given chemical, if an unacceptable risk is indicated by the evaluation, the NOAEL-MATC-, and LOAEL-based HQ values for that chemical was compared to the NOAEL-, MATC-, and LOAEL-based HQ value derived for spotted sandpiper dietary exposures at the estuarine wetland reference area. The reference area risk estimates were derived using the procedure presented above. The comparison determined if potential risks presented by ecological COCs in SWMU 2 estuarine wetland sediment exceed potential risks at the reference area.

Survival, growth, and reproduction of herbivorous West Indian manatees:

- *Comparison of maximum West Indian manatee dietary intakes to literature-based TRVs.* Maximum arsenic, cadmium, copper, lead, mercury, selenium, and zinc concentrations in field-collected turtle grass tissue (whole-plant and above ground portions) at SWMU 2 were used in place of modeled values to estimate dietary intakes for the West Indian manatee. Dietary intakes were estimated using the formula modified from USEPA (1993):

$$DI_x = \frac{[[\sum_i [(FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)]] [AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg-BW/day)
FIR	=	Maximum food ingestion rate (kg/day, dry weight)
FC_{xi}	=	Maximum concentration of chemical x in food item i (dry weight)
PDF_i	=	Proportion of diet composed of food item i (mg/kg, dry weight)
SC_x	=	Maximum concentration of chemical x in sediment (mg/kg, dry weight)
PDS	=	Proportion of diet composed of sediment (dry weight basis)
BW	=	mean body weight (kg, wet weight)
AUF	=	Area Use Factor (unitless)

Receptor-specific exposure parameters used for the West Indian manatee included a maximum food ingestion rate of 21.9 kg/day-dry weight (Etheridge et al., 1985) and minimum body weight of: 800 kg (United States Geological Survey [USGS], 2000a). These values were developed in the SERA and Step 3a of the BERA (Baker, 2006a). As the manatee is a strictly herbivorous species, the exposure diet was assumed to be 99 percent plant material (USFWS, 1986a and Odell, 1992) and one percent sediment (from incidental ingestion; USGS, 2000a). As discussed in the SERA (Baker, 2006a), no potential drinking water sources are available within the Ensenada Honda. As such, ingestion of surface water does not represent a potential complete exposure pathway and was not considered in risk calculations for West Indian manatee dietary exposures. It is noted that maximum ecological COC concentrations in turtle grass tissue and sediment, as well as a maximum food ingestion

rate and minimum body weight were used to derive dietary intakes for the West Indian manatee based on the endangered status of this species in Puerto Rico.

For the BERA, it was assumed that the West Indian manatee spends 100 percent of its time within the open water portion of SWMU 2 (i.e., an AUF of 1.0 was assumed). This is considered an overly conservative assumption given that West Indian manatees could spend a significant percentage of time foraging off-site in areas not impacted by site-related chemicals or areas where chemical concentrations are expected to be significantly lower. For example, the Florida population of the West Indian manatee ranges over fairly large areas during the summer (covering up to 200 linear kilometers [km] of river or coastline). Unlike the Florida population, which aggregates within the confines of natural or artificial warm water refuges during winter periods (USFWS, 1996c), there is no evidence of periodicity in manatee behavior in Puerto Rico (USFWS, 1986a). As such, it cannot be expected that West Indian manatees would forage exclusively within the Ensenada Honda (represented by approximately 6.2 miles of shoreline) or the portion of the Ensenada Honda within the boundary of SWMU 2 (represented by approximately 0.2 miles of shoreline).

Ingestion-based HQs for the West Indian manatee were calculated by dividing maximum dietary intakes by literature-based NOAEL and LOAEL values adjusted to reflect differences in body weights between mammalian test species and the West Indian manatee. Using the NOAEL as an example, ingestion-based TRVs were adjusted by the following scaling equation (Sample et al., 1996):

$$NOAEL_r = NOAEL_t(BW_t/BW_r)^{1/4}$$

where:

$NOAEL_r$	=	NOAEL of the receptor species (mg/kg-BW/day)
$NOAEL_t$	=	NOAEL of the test species (mg/kg-BW/day)
BW_r	=	Body weight of receptor species (kg)
BW_t	=	Body weight of test species (kg)

Test species NOAEL and LOAEL values, as well as the adjusted values used in the derivation of maximum arsenic, cadmium, copper, lead, mercury, selenium, and zinc HQ values for West Indian manatee dietary exposures are summarized in Table 2-15. As a measure of conservatism, it was assumed that all mercury in SWMU 2 sediment is present as MeHg. Therefore, mercury HQ values were derived using the NOAEL and LOAEL value from the study using MeHg chloride as the test material. In addition to NOAEL- and LOAEL-based risk estimates, HQ values were derived using MATCs (geometric mean of the adjusted NOAEL and LOAEL value). Based on the endangered species status of the West Indian manatee, NOAEL values are most appropriate for this receptor. As such, conclusions regarding the acceptability of risk are based on HQ values derived using NOAEL values (a NOAEL-based HQ value greater than 1.0 indicates the potential for unacceptable risk). Although not considered when determining the acceptability of risk, MATC- and LOAEL-based HQ values for each ecological COC also were derived to provide perspective on the range of potential risks since the NOAELs listed in Table 2-15 are, in part, artifacts of dose selection and do not represent actual threshold effects.

For a given chemical, if an unacceptable risk is indicated by the evaluation, the NOAEL-based HQ value for that chemical was compared to the NOAEL-based HQ value derived for West Indian manatee dietary exposures at the open water reference area. Reference area risk

estimates were derived using the procedure presented above. The comparison determined if potential risks presented by ecological COCs in SWMU 2 open water sediment exceed potential risks at the reference area.

Table 2-16 summarizes the decision rules and criteria used in Section 5.0 to outline potential recommendations and actions associated with these lines of evidence. Each line of evidence was not weighted equally. For example, the comparison of antimony, copper, lead, mercury, and zinc soil concentrations to literature-based toxicological thresholds doesn't account for site-specific characteristics that may influence the bioavailability of these chemicals to terrestrial invertebrates, nor do these comparisons account for effects of multiple chemicals, including additive, synergistic, or antagonistic effects. Therefore, the comparison of surface soil concentrations to ecological SSLs or literature-based toxicological is typically given little weight. Soil toxicity testing can account for site-specific characteristics (e.g., pH and TOC) that may influence chemical bioavailability. Toxicity testing can also account for the effects of multiple chemicals. For these reasons, toxicity testing is typically given greater weight when developing recommendations for a site.

3.0 FIELD INVESTIGATION SUMMARY

The sections that follow detail the various investigation activities that were implemented in conjunction with the BERA at SWMU 2 (i.e., verification of field sampling design [Step 5] and BERA field investigation [Step 6]). Any modifications to the FSAP presented within the Final Steps 3b and 4 Report (Baker, 2007) are identified and rationale for each modification is included within the discussion. A copy of the field notes scribed during the Step 5 field verification and Step 6 BERA field investigation activities are provided as Appendix C, while Chain-of-Custody forms that accompanied the samples from the field to the analytical and toxicity testing laboratories and data validators are provided as Appendix D. The evaluation of the analytical data and toxicity test results is presented in Section 4.0.

3.1 Verification of BERA Field Sampling Design

Prior to mobilization for the BERA field investigation (Step 6), the field sampling design was verified in the field (Step 5 of the Navy ERA process; see Figure 1-1) to ensure that the BERA study design was appropriate and could be implemented at SWMU 2. The testable hypotheses, exposure pathway models, and measurement endpoints also were evaluated for their appropriateness. By verifying the field sampling design prior to conducting the field investigation, well-considered alterations to the study design can be made. It is noted that field verification activities for the BERA at SWMU 2 were conducted concurrently with field verification activities for a BERA at SWMU 1. The BERA for SWMU 1 was presented in a separate document (Baker, 2009). Therefore, the description of the Step 5 field verification presented within the paragraphs that follow is limited to activities conducted for the BERA at SWMU 2. The evaluation of analytical data generated during field verification sampling activities (see Section 4.0) also is limited to an evaluation of data specific to SWMU 2.

The lines of evidence employed in the BERA at SWMU 2 (see Section 2.5.4) included the comparison of *Eisenia fetida* survival, growth, and reproduction in SWMU 2 soil with *Eisenia fetida* survival, growth, and reproduction in reference soil. This line of evidence requires that soil samples be collected from an upland (i.e., terrestrial) area not known to be impacted by contaminant sources, termed a reference area. A second line of evidence identified in Section 2.5.4 involves the comparison of *Leptocheirus plumulosus* survival, growth, and reproduction and *Neanthes arenaceodentata* survival and growth in SWMU 2 estuarine wetland sediment to *Leptocheirus plumulosus* survival, growth, and reproduction and *Neanthes arenaceodentata* survival and growth in estuarine wetland reference sediment. A third line of evidence involves the comparison of ingestion-based risk estimates (95 percent UCL of the mean HQs) for estuarine wetland avian invertivore dietary exposures at SWMU 2 to ingestion-based risk estimates (95 percent UCL of the mean HQs) for avian invertivore dietary exposures at a reference area. These two lines of evidence require that sediment and fiddler crab tissue samples be collected from an estuarine wetland area not known to be impacted by contaminant sources. A fourth line of evidence involves the comparison of ingestion-based risk estimates (maximum HQs) for West Indian manatee dietary exposures at SWMU 2 to ingestion-based risk estimates for West Indian manatee dietary exposures at a reference area. This line of evidence requires the collection of sediment and seagrass tissue samples from an open water area not known to be impacted by contaminant sources. Based on these lines of evidence, one of the primary objectives of the verification of the BERA field sampling design at SWMU 2 was the identification of appropriate reference areas for the collection of soil, sediment (estuarine wetland and open water sediment) and tissue (fiddler crab and seagrass tissue).

3.1.1 Terrestrial Habitat

Activities associated with verification of the BERA field sampling design for terrestrial habitat were conducted from February 27, 2007 to March 1, 2007, and included the collection of surface and subsurface soil at SWMU 2 and three upland reference areas (Upland Reference Area No. 1, Upland Reference Area No. 2, and Upland Reference Area No. 3). The upland reference areas (see Figure 3-1) were identified based on the lack of apparent contaminant influences and the presence of terrestrial habitat similar to that identified at SWMU 2 (upland forest community adjacent to estuarine wetland habitat; as determined by field observations and/or examination of Figures 2-3 and 2-5). Upland Reference Area No. 1 was established approximately 0.17 miles north of SWMU 2, Upland Reference Area No. 2 was established north of Kearsage Road, between SWMUs 1 and 2 (approximately 0.11 miles north of SWMU 1 and 0.17 miles southwest of SWMU 2), while Upland Reference Area No. 3 was established approximately 0.16 miles south of SWMU 1. Although each upland reference area is located adjacent to SWMUs 1 and/or 2, all three reference areas are topographically upgradient of impacted soils at these two SWMUs.

Table 3-1 provides a summary of the soil samples collected at SWMU 2 and each of the upland reference areas during verification of the field sampling design. Included within the table are the associated field quality assurance/quality control (QA/QC) samples. As evidenced by the table, six surface soil samples (2V-SS01 through 2V-SS06) and six subsurface soil samples (2V-SB01 through 2V-SB06) were collected at SWMU 2, four surface soil samples and four subsurface soil samples were collected at Upland Reference Area No. 1 (REF-SS/SB01 through REF-SS/SB04) four surface soil and three subsurface soil samples were collected at Upland Reference Area No. 2 (REF-SS/SB05, and REF-SS/SB06 through REF-SS/SB08), and four surface soil and four subsurface soil samples were collected at Upland Reference Area No. 3 (REF-SS/SB09 through REF-SS/SB12). Sample locations were georeferenced with a Global Positioning System (GPS) at the time of sampling and are shown on Figure 3-2. It is noted that the Final Steps 3b and 4 Report for SWMU 2 (Baker, 2007) specified the collection of four surface and four subsurface soil samples at each of the proposed reference areas. However, as indicated above, only three subsurface soil samples were collected at Upland Reference Area No.2 due to bucket auger refusal at the REF-SB05 sampling point, which prevented the collection of a subsurface soil sample at this location.

All SWMU 2 and upland reference area surface soil samples were collected from the 0 to 1-foot depth interval and all subsurface soil samples were collected from the 1.0 to 2.0-foot depth interval using dedicated stainless steel bucket augers (bucket augers were not re-used after initial use). Soil was dispensed from the bucket augers directly into aluminum pans, mixed with dedicated stainless steel spoons, and dispensed into sample jars for shipment to the analytical laboratory (Severn Trent Laboratories [STL] located in Savannah, Georgia). The SWMU 2 soil samples were analyzed for TOC, grain size, and pH. The Final Steps 3b and 4 Report (Baker, 2007) specified that two of the four surface soil samples and two of the four subsurface soil samples collected at each upland reference area would be analyzed for antimony, copper, lead, mercury, and zinc (ecological COCs identified in Step 3a of the Navy ERA process for terrestrial invertebrate direct contact exposures [Baker, 2006a]), as well as TOC, grain size, and pH. The remaining two surface and subsurface soil samples collected at each upland reference area would be analyzed for an expanded list of analytes (i.e., polycyclic aromatic hydrocarbons [PAHs], Appendix IX organochlorine pesticides, Appendix IX metals, TOC, pH, and grain size). Analyses were performed on a standard-turn (i.e., 28-days) using the methodology summarized in Table 3-2. The expanded analyte list was requested by the USEPA in their comment letter dated December 8, 2006 on the *Draft Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2* (Baker, 2006b). This approach was followed at Upland Reference Area Nos. 1 and 3 (see Table 3-1). However, only one subsurface soil sample collected at Upland Reference Area No. 2 was analyzed for the expanded analyte list (REF-SB06).

As discussed in the preceding paragraph, a subsurface soil sample was not collected at REF-SB05 due to bucket auger refusal. This planned sample was designated for evaluation using the expanded analyte list.

As outlined in the Final Steps 3b and 4 Report (Baker, 2007), the proposed upland reference areas were evaluated based on physical, chemical, and biological properties. A given upland reference area was deemed acceptable for use as a source of soil during the BERA field investigation (Step 6) for *Eisenia fetida* toxicity testing if the following conditions were met:

- The range of TOC concentrations and grain size characteristics in upland reference area soil are similar to the ranges found in soil located within the study area (SWMU 2 upland habitat). This criterion was established since *Eisenia fetida* response in toxicity tests can be influenced by these soil characteristics (ASTM, 2006a).
- Maximum PAH, Appendix IX metal, and Appendix IX organochlorine pesticide concentrations in upland reference area soil do not exceed the soil screening values listed in Table 3-3. Ecological SSLs based on terrestrial invertebrates or, in the case of chemicals lacking invertebrate-based ecological SSLs, toxicological data eligible for ecological SSL derivation were preferentially selected as soil screening values. Earthworm-based toxicological thresholds developed by Efroymson et al. (1997b) were selected as soil screening values for those chemicals lacking an invertebrate-based ecological SSL or toxicological data eligible for invertebrate-based ecological SSL development. For those chemicals lacking an invertebrate-based ecological SSL, toxicological data eligible for ecological SSL development, and an earthworm-based toxicological threshold from Efroymson et al. (1997a), the following literature-based values, listed in their order of decreasing preference, were selected as soil screening values:
 - Ecological SSLs for terrestrial plants (<http://www.epa.gov/ecotox/ecossl/>)
 - Plant-based toxicological data eligible for Eco-SSL derivation
 - Toxicological thresholds for plants (Efroymson et al., 1997a)
 - Soil standards developed by Ministry of Housing, Spatial Planning and Environment (MHSPE, 2000), assuming a minimum default soil organic carbon content of 2.0 percent
 - Background-based soil-screening values reported by Friday (1998)

Background-based soil screening values were given the lowest preference since they do not represent effect-based concentrations. This criterion ensures that reference soil does not contain chemical concentrations that could impact *Eisenia fetida* survival, growth, and/or reproduction. For metals detected at concentrations greater than soil screening values, analytical data were compared to background surface and subsurface soil screening values (upper limit of the mean [ULM] concentrations; mean background concentration plus two standard deviations) established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008a). For subsurface soil, background data for clay soils and fine sand/silt soils were used in the comparison. Both background soil types were included in the evaluation since the grain size characteristics of subsurface soil collected at each upland reference area showed considerable variability (see Section 4.1.1 and Tables 4-6 through 4-8). A given reference area was still

deemed acceptable for use as a source of soil in the BERA field investigation if maximum detected surface and subsurface soil concentrations were less than background screening values.

- Maximum lead, mercury, and zinc concentrations in upland reference area surface soil and maximum copper, lead, and zinc concentrations in upland reference area subsurface soil do not exceed the background surface and subsurface soil screening values established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Copper: 168 mg/kg [ULM for background clay subsurface soil]; lead: 22 mg/kg [ULM for background surface soil] and 6.3 mg/kg [ULM for background clay subsurface soil]; mercury: 0.109 mg/kg [ULM for background surface soil]; zinc: 115 mg/kg [ULM for background surface soil] and 88 mg/kg [ULM for background clay subsurface soil] [Baker, 2008a]). This criterion ensures that reference area subsurface soil does not contain copper, lead, and zinc (ecological COC for terrestrial avian omnivore dietary exposures) at concentrations that may bioaccumulate in earthworms above what would be expected under background conditions.

3.1.2 Estuarine Wetland Habitat

Activities associated with verification of the BERA field sampling design for estuarine wetland habitat were conducted from February 28, 2007 to March 1, 2007, and included the collection of sediment at SWMU 2 and an estuarine wetland reference area. The estuarine wetland reference identified for evaluation is located within the Los Machos mangrove forest, north of Antietam Road (see Figure 3-1). The area contains habitat identical to that present within the estuarine wetland portion of SWMU 2 (i.e., black and red mangroves). This area was used as a source of background sediment for a Corrective Measures Study (CMS) investigation at SWMU 9 (Baker, 2003). Analytical data for these background sediment samples collected during the SWMU 9 CMS investigation have been incorporated into the NAPR background estuarine wetland data set (Baker, 2008a), supporting the selection of this area as a potential source of reference sediment and fiddler crab tissue for the BERA field investigation.

Table 3-1 includes a summary of the estuarine wetland sediment samples collected at SWMU 2 and the reference area during verification of the field sampling design. Included within the table are the associated field QA/QC samples. As evidenced by the table, six sediment samples were collected at SWMU 2 (2V-EWSD01 through 2V-EWSD06) and the reference area (REF-EWSD01 through REF-EWSD06). Sample locations were georeferenced with a GPS at the time of sampling and are shown on Figure 3-3. Reference area sample locations were chosen to be as similar as possible to the estuarine wetland system downgradient from SWMU 2 with regard to vegetation, vegetative cover, and visual sediment characteristics (e.g., color and texture). All SWMU 2 and estuarine wetland reference area sediment samples were collected from the 0.0 to 0.5-foot depth interval using dedicated stainless steel spoons (spoons were not re-used after initial use). Sediment was dispensed from the stainless steel spoons directly into sample jars for shipment to the analytical laboratory (STL-Savannah). The SWMU 2 sediment samples were analyzed for ammonia, sulfide, pH, and grain size, while the reference area sediment samples were analyzed for copper, lead, mercury, and zinc (ecological COCs identified in Step 3a of the Navy ERA process for terrestrial invertebrate direct contact exposures and/or avian invertivore dietary exposures [Baker, 2006a]), as well as ammonia, sulfide, pH, TOC, and grain size. Analyses were performed on a standard-turn (i.e., 28 days) using the methodology summarized in Table 3-2.

As outlined in the Final Steps 3b and 4 Report (Baker, 2007), the proposed estuarine wetland reference area was evaluated based on physical, chemical, and biological properties. The estuarine

wetland reference area was deemed acceptable for use as a source of sediment for *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity testing and for fiddler crab tissue collection during the BERA field investigation (Step 6) if the following conditions were met:

- The habitat offered by the estuarine wetland reference area is similar to habitat found within the estuarine wetland portion of SWMU 2 (mangrove community). This criterion ensures that the reference area is capable of supporting a fiddler crab population and represents potential feeding habitat for avian invertivores.
- The ranges of ammonia, sulfide, and TOC concentrations, as well as the range of grain size characteristics in estuarine wetland reference area sediment are similar to the ranges found in SWMU 2 estuarine wetland sediment. This criterion was established since *Leptocheirus plumulosus* and *Neanthes arenaceodentata* response in toxicity tests can be influenced by these sediment characteristics (USEPA, 2001a and ASTM, 2006b).
- Maximum copper, lead, mercury, and zinc concentrations in estuarine wetland reference area sediment do not exceed the sediment screening values developed in Step 1 of the Navy ERA process and listed in Section 2.5.4 (copper: 18.7 [MacDonald, 1994]; lead: 30.2 mg/kg [MacDonald, 1994]; 0.17 mg/kg for mercury, and zinc: 124 mg/kg [MacDonald, 1994]). This criterion ensures that reference sediment does not contain ecological COCs at concentrations that could impact *Leptocheirus plumulosus* survival, growth, and reproduction and *Neanthes arenaceodentata* survival and growth. For metals detected at concentrations greater than sediment screening values, analytical data were compared to the estuarine wetland background sediment screening values (ULM concentrations for background estuarine wetland sediment) established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008a). The reference area was still deemed acceptable for use in the BERA field investigation as a source of sediment for *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity testing if maximum detected concentrations were less than background screening values.
- Maximum lead and mercury concentrations in estuarine wetland reference area sediment do not exceed the background estuarine wetland sediment screening values established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (lead: 25.4 mg/kg; mercury: 0.17 mg/kg [Baker, 2008a]). This criterion ensures that reference sediment does not contain lead and mercury (ecological COC for avian invertivore dietary exposures) at concentrations that may bioaccumulate in fiddler crab tissue above what would be expected under background conditions.

3.1.3 Open Water Habitat

Three open water reference areas (Open Water Reference Area No. 1, Open Water Reference Area No. 2, and Open Water Reference Area No. 3) were previously evaluated during Step 5 of the ERA process for SWMU 45 (Baker, 2008b). The open water reference areas (see Figure 3-1) were identified based on the lack of apparent contaminant influences and the likely presence of seagrass habitat similar to that present at SWMU 45 and SWMU 2 (i.e., turtle grass community). Open Water Reference Area No. 1 was established within Puerca By, Open Water Reference Area No. 2 was established within an Embayment of the Ensenada Honda, adjacent to the former Officer's Beach (approximately 1.0 mile from the open water portion of SWMU 1), while Open Water Reference Area No. 3 was established within Pelican Bay. The proposed location of Reference Area No. 3 (Baker, 2006c and 2007) was relocated during the SWMU 45 field verification sampling event due to

the presence of a cliff face, which prevented access to the proposed location from land. The new location was established within Pelican Bay, adjacent to Franklin D. Roosevelt Drive (see Figure 3-1). The evaluation of each open water reference area during the SWMU 45 field verification investigation included the collection and analysis of sediment samples for the ecological COCs unique to SWMU 2 West Indian manatee dietary exposures (i.e., arsenic, cadmium, copper, lead, mercury, selenium, and zinc). Therefore, additional evaluation of the open water reference areas was not conducted during verification of the field sampling design at SWMU 2.

Table 3-4 provides a summary of the sediment samples and associated QA/QC samples collected at each open water reference area during the SWMU 45 field verification sampling event. Six sediment samples were collected at Open Water Reference Area No. 1 (REF1-SD01V through REF1-SD06V) and Open Water Reference Area No. 2 (REF2-SD01V through REF2-SD06V), while two sediment samples were collected at Open Water Reference Area No. 3 (REF3-SD01V and REF3-SD02V). Identical to the soil and estuarine wetland sediment samples collected at SWMU 2 and the upland and estuarine wetland reference areas, open water reference area sediment sample locations were georeferenced with a GPS at the time of sampling and are shown on Figures 3-4 (Open Water Reference Area No. 1) and 3-5 (Open Water Reference Area Nos. 2 and 3). All reference area sediment samples were collected from the 0.0 to 0.5-foot depth interval using dedicated sediment core liners (core liners were disposed of after each use). Sediment was dispensed from the core liners directly into sample jars for shipment to the analytical laboratory (STL-Savannah). Each open water reference area sediment sample included analyses for the ecological COCs unique to SWMU 2 (arsenic, cadmium, copper, lead, mercury, selenium, and zinc), as well as TOC and grain size. Analyses were conducted on a standard turn (i.e., 28 days) using the methodology summarized in Table 3-2.

It is noted that the Final Steps 3b and 4 Report for SWMU 45 and SWMU 2 (Baker, 2006c and 2007, respectively) specified the collection of six sediment samples at each of the proposed reference areas. However, as indicated above, only two sediment samples were collected from Reference Area No. 3. The number of samples collected at this open water reference area was reduced during the SWMU 45 field verification sampling event based on low seagrass coverage (i.e., seagrass cover was less than ten percent).

As outlined in the Final Steps 3b and 4 Report (Baker, 2007), the proposed open water reference areas were evaluated based on physical, chemical, and biological properties. A given open water reference area was deemed acceptable for use as a source of seagrass tissue during the BERA field investigation (Step 6) if the following conditions were met:

- The habitat offered by the reference area is similar to habitat found within the open water portion of SWMU 2 (turtle grass community). This criterion ensures that the reference area represents potential feeding habitat for West Indian manatees (manatees preferentially feed on turtle grass across all age classes and genders [see Section 2.5.2]).
- The range of TOC concentrations and grain size characteristics in open water reference area sediment are similar to the ranges found in sediment located within the open water portion of SWMU 2. This criterion was established since TOC and grain size can influence the bioavailability of metals in sediment (John and Leventhal, 1995, NFESC, 2000, Pereira et al., 2008, Warren et al., 1994, and Wood and Shelley, 1999).
- Maximum arsenic, cadmium, copper, lead, mercury, selenium, and zinc concentrations in open water reference area sediment do not exceed the background open water sediment screening values established within the *Revised Final II Summary Report for Environmental*

Background Concentrations of Inorganic Compounds ([arsenic: 10.5 mg/kg; cadmium: 1.52 mg/kg; copper: 29 mg/kg; lead: 5.4 mg/kg; mercury: 0.056 mg/kg; selenium: 1.08 mg/kg; zinc: 32 mg/kg [Baker, 2008a]). This criterion ensures that open water reference area sediment does not contain arsenic, cadmium, copper, lead, mercury, selenium, and zinc at concentrations that may bioaccumulate in turtle grass tissue above what would be expected under background conditions.

3.2 BERA Field Investigation

Sampling activities associated with the BERA field investigation (Step 6) were conducted from May 18, 2007 to May 20, 2007. Surface and subsurface soil samples were collected from SWMU 2 and an upland reference area (Reference Area No. 2) in support of *Eisenia fetida* toxicity tests. Earthworms maintained in soil during toxicity testing also were collected from test chambers during toxicity testing at test termination for whole-body analyses (insufficient earthworm tissue was encountered in the field during surface soil collection activities). In addition to soil and earthworm tissue, sediment was collected from the estuarine wetland portion of SWMU 2 and the estuarine wetland reference area in support of *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity tests. Fiddler crab tissue samples also were collected from the estuarine wetland portion of SWMU 2 and the estuarine wetland reference area. Finally, above ground and whole-plant tissue samples were collected from the open water portion of SWMU 2. Sampling activities within the open water portion of SWMU 2 included the collection of co-located sediment samples at each turtle grass tissue sampling location. The earthworm, fiddler crab, and turtle grass tissue analytical data were used in place of modeled tissue concentrations to estimate dietary intakes for terrestrial avian omnivore, semi-aquatic avian invertivore, and West Indian manatee food web exposures, respectively. As discussed in Section 3.1.3, turtle grass tissue and co-located sediment samples were collected from Open Water Reference Area No. 2 during the BERA field investigation at SWMU 45 (conducted from January 28, 2007 to January 31, 2007). Soil, estuarine wetland sediment, open water sediment, fiddler crab tissue, and turtle grass tissue sampling activities are described in the sections that follow. Analytical results for the abiotic and biotic media collected during the BERA field investigation are presented and discussed in Section 4.0.

3.2.1 Soil Sampling in Support of Earthworm Toxicity Tests

A total of fifty surface soil samples, designated 2B-SS01 through 2B-SS50 were collected within the upland habitat at SWMU 2 in support of the 28-day *Eisenia fetida* survival, growth, and reproduction toxicity tests (see Table 3-5). Sampling locations were identified by establishing four 10-foot by 10-foot sampling grids centered around each of ten soil sampling points previously evaluated during the 1992 SI, 1996 RFI and/or 2004 additional data collection field investigation (2SB01, 2SB03, 2SB05, 2SS02, 2SS03/06SS103 [2SS03 represents a 2004 additional data collection surface soil sampling point co-located with 1992 SI subsurface soil sampling point 06SS103], 2SS05, 2SS10, 2SS11, 2SS14, and 06SS101 [see Figure 3-6). At each of the ten historical sampling points, a total of five surface soil samples were collected from the 0.0 to 1.0-foot depth interval (one from each of four 10-foot by 10-foot sampling grids and one from the location of the historical sampling point]). The location sampled within a grid was determined in the field and was biased toward potential depositional areas (i.e., depressions/low points). The ten historical sampling points identified above were targeted for sampling during the BERA field investigation because ecological COC concentrations at these locations span the range of known concentrations detected in SWMU 2 soil during previous investigations (see Tables 2-4 and 2-5). BERA sample designations assigned to surface soil collected at each historical sampling point are identified within the following table. This information also is included within Table 3-5.

Historical Sample Location	BERA Sample Designation
2SS03/06SS103	2B-SS01, 2B-SS02, 2B-SS03, 2B-SS04, and 2B-SS05
06SS101	2B-SS06, 2B-SS07, 2B-SS08, 2B-SS09, and 2B-SS10
2SS11	2B-SS11, 2B-SS12, 2B-SS13, 2B-SS14, and 2B-SS15
2SS14	2B-SS16, 2B-SS17, 2B-SS18, 2B-SS19, and 2B-SS20
2SS10	2B-SS21, 2B-SS22, 2B-SS23, 2B-SS24, and 2B-SS25
2SB05	2B-SS26, 2B-SS27, 2B-SS28, 2B-SS29, and 2B-SS30
2SS05	2B-SS31, 2B-SS32, 2B-SS33, 2B-SS34, and 2B-SS35
2SS02	2B-SS36, 2B-SS37, 2B-SS38, 2B-SS39, and 2B-SS40
2SB03	2B-SS41, 2B-SS42, 2B-SS43, 2B-SS44, and 2B-SS45
2SB01	2B-SS46, 2B-SS47, 2B-SS48, 2B-SS49, and 2B-SS50

It is noted that the Final Steps 3b and 4 Report (Baker, 2007) specified that a total of 55 surface soil samples would be collected during the BERA field investigation. However, only fifty surface soil samples were collected. This discrepancy can be attributed to the incorrect identification of historical sample location 2SS03/06SS103 as two unique sample locations in the Final Steps 3b and 4 Report (Baker, 2007).

In addition to surface soil, eight subsurface soil samples, designated 2B-SB01-01, 2B-SB02-01, 2B-SB04-01, and 2B-SB06-01 through 2B-SB10-01, were collected from the 1.0 to 2.0-foot depth interval in support of the 28-day *Eisenia fetida* survival, growth, and reproduction toxicity tests (see Table 3-5 for a list of subsurface soil samples). The subsurface soil samples were co-located with surface soil samples at two historical sampling points (2SS03/06SS103 and 06SS101):

- Subsurface soil sample 2B-SB01-01: co-located with surface soil sample 2B-SS01
- Subsurface soil sample 2B-SB02-01: co-located with surface soil sample 2B-SS02
- Subsurface soil sample 2B-SB04-01: co-located with surface soil sample 2B-SS04
- Subsurface soil sample 2B-SB06-01: co-located with surface soil sample 2B-SS06
- Subsurface soil sample 2B-SB07-01: co-located with surface soil sample 2B-SS06
- Subsurface soil sample 2B-SB08-01: co-located with surface soil sample 2B-SS06
- Subsurface soil sample 2B-SB09-01: co-located with surface soil sample 2B-SS06
- Subsurface soil sample 2B-SB10-01: co-located with surface soil sample 2B-SS06

Sample locations 2SS03/06SS103 and 06SS101 were targeted for subsurface soil collection during the BERA field investigation because maximum copper, lead, and/or zinc concentrations in SWMU 2 soil were detected in subsurface soil collected at these locations during the 1992 SI (see Section 2.5.2). It is noted that the Final Steps 3b and 4 Report (Baker, 2007) specified that a total of ten subsurface soil samples would be collected during the BERA field investigation for (five subsurface soil samples at 2SS03/06SS103 and five subsurface soil samples at 06SS101). However, only three subsurface soil samples were collected at 2SS03/06SS103 (2B-SB01-01, 2B-SB02-01, and 2B-SB04-01) due to sampling equipment refusal within the depth interval specified for subsurface soil

collection (1.0 to 2.0-foot depth interval). As such, surface soil samples 2B-SS03 and 2B-SS05 lack co-located subsurface soil samples.

In addition to the SWMU 2 surface and subsurface soil samples, a total of six surface soil samples (designated 2B-REF-SS01 through 2B-REF-SS06) and six subsurface soil samples (designated 2B-REF-SB01-01 through 2B-REF-SB06-01) were collected from Upland Reference Area No. 2 for use as potential reference samples for *Eisenia fetida* toxicity testing (see Figure 3-7). Identical to SWMU 2, reference area surface soil was collected from the 0.0 to 1.0-foot depth interval, while reference area subsurface soil was collected from the 1.0 to 2.0-foot depth interval. Each subsurface soil sample was co-located with a surface soil sample. For example, subsurface soil sample 2B-REF-SB01-01 (1.0 to 2.0-foot depth interval) was co-located with surface soil sample 2B-REF-SS01 (0.0 to 1.0-foot depth interval).

The SWMU 2 and Upland Reference Area No. 2 soil samples were collected using one of two methods. Stainless steel hand augers were used at those locations where co-located surface and subsurface soil samples were collected, while stainless steel spoons were used at those locations where only surface soil was collected. Soil was dispensed from the stainless steel bucket augers/spoons directly into one-gallon containers. At a given location, once the one-gallon sample container was filled, the contents were homogenized using a stainless steel spoon and a portion was transferred to sample jars for submittal to the analytical laboratory (STL-Pittsburgh, STL-Savannah, or STL-Seattle) for the following quick-turn (i.e., 48-hour) analysis using the methodology presented in Table 3-6: antimony, copper, lead, mercury, and zinc. The remaining soil was held in the one-gallon sample container on ice until the quick-turn results were available from the analytical laboratory.

Upon receipt of the quick-turn (unvalidated) analytical results in the field, eleven SWMU 2 surface soil samples and one SWMU 2 subsurface sample were selected from the sample portions held on ice and submitted to the toxicity testing laboratory (Fort Environmental Laboratories, Inc. located in Stillwater, Oklahoma) for 28-day *Eisenia fetida* survival, growth, and reproduction toxicity tests. Ecological COC concentrations in the SWMU 2 soil samples submitted for toxicity testing (2B-SS04, 2B-SS05, 2B-SS10, 2B-SS13, 2B-SS14, 2B-SS31, 2B-SS33, 2B-SS34, 2B-SS41, 2B-SS44, 2B-SS49, and 2B-SB04-01) span the range of concentrations measured in the quick-turn samples (i.e., non-detected concentrations or concentrations less than soil screening values to maximum detected concentrations). In addition to the twelve SWMU 2 soil samples, three soil samples (two surface soil samples [2B-REF-SS04 and 2B-REF-SS05] and one subsurface soil sample [2B-REF-SB01-01]) collected at Upland Reference Area No. 2 were selected for toxicity testing. The upland reference area soil samples selected for toxicity testing met the antimony, copper, lead, mercury, and zinc criteria specified in Section 3.1.1 (i.e., ecological COC concentrations are less than the soil screening values listed in Table 3-3 and/or the background screening values established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* [Baker, 2008a])). These three soil samples also exhibited similar physical characteristics as those observed in soils collected at SWMU 2 and submitted for toxicity testing (apparent, based on professional judgment). Each SWMU 2 and upland reference area surface soil sample submitted for toxicity testing was analyzed for TOC, pH, and grain size using the methodology presented in Table 3-6.

3.2.2 Earthworm Toxicity Testing

Direct toxicity to terrestrial invertebrates was evaluated using 28-day *Eisenia fetida* survival, growth, and reproduction tests. Tests were conducted in accordance with Standard E 1676-04: *Standard Guide for Conducting Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia*

Fetida and the *Enchytraeid* Potworm *Enchytraeus Albidus* (ASTM, 2006a). Test endpoints for *Eisenia fetida* were survival, calculated as the mean percentage of test organisms at test initiation that survived in each replicate at test termination, growth, calculated as the mean wet weight loss per surviving earthworm in each replicate at test termination, and reproduction, expressed as the mean number of juveniles and cocoons per surviving earthworm in each replicate at test termination.

Each reference area and SWMU 2 soil sample was tested using eight replicate chambers, with ten earthworms per replicate (eighty earthworms per sample). The toxicity testing laboratory's SOW (Appendix B) and ASTM Standard E 1676-04 specify the acceptable laboratory control performance criteria and testing procedures for the *Eisenia fetida* toxicity tests. The laboratory control data (mean survival of 98.75 percent survival) indicate that earthworm performance exceeded the minimum acceptability criteria specified by ASTM Standard E 1676-04 (mean survival greater than or equal to 80 percent). Furthermore, no protocol deviations were observed or recorded during the performance of the toxicity tests. The toxicity test report summarizing the toxicity evaluations using *Eisenia fetida* is included as Appendix E. The results of the toxicity tests are presented and discussed in Section 4.2.2.

3.2.3 Earthworm Tissue

Earthworms maintained in soil during toxicity testing were used to evaluate terrestrial avian omnivore food web exposures to ecological COCs in SWMU 2 soil. One composite tissue sample was prepared for each soil sample tested for toxicity (twelve SWMU 2 soil samples and three Upland Reference Area No. 2 soil samples [see Table 3-5]) by combining all surviving earthworms from each replicate at test termination. Surviving earthworms were transferred to vessels containing damp filter paper for depuration. After depuration, earthworms were transferred to sample containers, frozen, and shipped to the analytical laboratory (STL-Savannah). Each earthworm tissue sample was analyzed for antimony, copper, lead, mercury, zinc and percent lipids using the methodology summarized in Table 3-6. It is noted that the Final Step 3b and 4 Report (Baker, 2007) specified that earthworm tissue samples would only be analyzed for copper, lead, mercury, zinc, and percent lipids. Although antimony was not identified as ecological COC for terrestrial avian omnivore food web exposures in Step 3a of the BERA (Baker, 2006a), this metal was added to the earthworm tissue analyte list because the maximum concentration in SWMU 2 soil was detected in soil samples collected during the BERA field investigation.

3.2.4 Estuarine Wetland Sediment Sampling

A total of twenty-three estuarine wetland sediment samples, designated 2B-EWSD01 through 2B-EWSD16 and 2B-EWSD18 through 2B-EWSD24, were collected at SWMU 2 in support of the 28-day *Leptocheirus plumulosus* survival, growth, and reproduction toxicity tests and 20-day *Neanthes arenaceodentata* survival and growth toxicity tests (see Table 3-5). As outlined in the FSAP presented within the Final steps 3b and 4 report (Baker, 2007), this was accomplished by establishing 25-foot by 25-foot sampling grids within the estuarine wetland system downgradient from SWMU 2 (Figure 3-8). The area encompassed by the grid system was selected to include locations previously sampled during the 2003 and 2004 additional data collection investigations. The FSAP specified that a single sediment sample would be collected from the center point of each grid (total of twenty-four sediment samples). However, several modifications to the FSAP were necessary based on conditions encountered in the field at the time that samples were collected. These modifications are listed below.

1. A sediment sample was not collected within Grid No. 17 since the area encompassed by this sampling grid is located entirely within terrestrial habitat.

2. The majority of Grid Nos. 16 and 24 are located within terrestrial habitat. The sediment sampling point within Grid No. 24 was established at the center point of the grid portion located within estuarine wetland habitat. In the case of Grid No. 24, only the southeastern border of the grid is located within estuarine wetland habitat. As such, the sediment sampling point within this grid was established on the grid's boundary with Grid No. 15.
3. In most cases, the center point of the remaining sampling grids could not be accessed due to dense stands of red mangrove. When vegetation prevented access to grid center points, sediment sampling points were established as close as possible to the grids' center points.

Sediment sample locations within each grid were georeferenced with a GPS at the time of sampling and are shown on Figure 3-9. Sample designations (2B-EWSD01 through 2B-EWSD16 and 2B-EWSD18 through 2B-EWSD24) are consistent with the 25-foot by 25-foot grid labels shown on Figure 3-8. For example, 2B-EWSD-01 was collected within Grid No. 1. In addition to the SWMU 2 estuarine wetland sediment samples, six sediment samples (designated 2B-REF-EWSD01 through 2B-REF-EWSD06) were collected from the estuarine wetland reference area for use as potential reference sediment samples for the *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity tests. Identical to the SWMU 2 estuarine wetland sediment samples, reference area sediment sampling locations were georeferenced with a GPS at the time of sampling and are shown on Figure 3-10.

The SWMU 2 and reference area sediment samples were collected from the 0.0 to 0.5-foot depth interval using dedicated stainless steel spoons. Sediment was dispensed from the stainless steel spoons directly into one-gallon containers. At a given sampling location, once the one-gallon sample container was filled, the contents were homogenized with the same stainless steel spoon used for sample collection and a portion was transferred to sample jars for submittal to the analytical laboratory (STL-Savannah) for quick-turn (i.e., 48-hour) copper, lead, mercury, and zinc analyses using the methodologies presented in Table 3-6. Copper, lead, and zinc represent the chemicals identified as ecological COCs in Step 3a of the ERA process for estuarine wetland aquatic invertebrates. Lead and mercury represent the chemicals identified as ecological COC in Step 3a of the ERA process for estuarine wetland avian invertivores. The remaining sediment was held in the one-gallon sample container on ice until the quick-turn results were available from the analytical laboratory.

Upon receipt of the quick-turn (unvalidated) analytical results in the field, eight SWMU 2 estuarine wetland sediment samples were selected and submitted to the toxicity testing laboratory (Fort Environmental Laboratories, Inc., Stillwater, Oklahoma) for 28-day *Leptocheirus plumulosus* survival, growth, and reproduction toxicity tests and 20-day *Neanthes arenaceodentata* survival and growth tests. Copper, lead, and zinc concentrations in the SWMU 2 estuarine wetland sediment samples submitted for toxicity testing (2B-EWSD04, 2B-EWSD09, 2B-EWSD12, 2B-EWSD15, 2B-EWSD16, 2B-EWSD18, 2B-EWSD20, and 2B-EWSD24) span the range of concentrations measured in the quick-turn samples (i.e., non-detected concentrations or concentrations less than sediment screening values to maximum detected concentrations). Because mercury does not represent an ecological COC for aquatic invertebrates, data for this metal was not taken into consideration when selecting sediment samples for toxicity testing (this metal was eliminated from additional evaluation in Step 3a of the ERA process [Baker, 2006a]). However, mercury concentrations detected in samples submitted for toxicity testing also span the range of concentrations measured in the quick-turn samples, including the maximum concentration (0.81 mg/kg in 2B-EWSD16).

In addition to the SWMU 2 estuarine wetland sediment samples, two of the six sediment samples collected from the estuarine wetland reference area (2B-REF-EWSD01 and 2B-REF-EWSD02) were

selected for toxicity testing. The sediment samples selected for toxicity testing met the copper, lead, and zinc criteria specified in Section 3.1.1 (i.e., ecological COC concentrations do not exceed the sediment screening values identified in Section 2.5.4 and/or the background screening values established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* [Baker, 2008a]). These two sediment samples also exhibited similar physical characteristics as those observed in sediment collected at SWMU 2 and submitted for toxicity testing (apparent, based on professional judgment). Each SWMU 2 and upland reference area sediment sample submitted for toxicity testing also was analyzed for TOC, pH, grain size, ammonia, sulfide, AVS, and SEM using the methodology presented in Table 3-6.

3.2.5 Amphipod and Polychaete Toxicity Testing

Direct toxicity to benthic invertebrates within the estuarine wetland system downgradient from SWMU 2 was evaluated using 28-day *Leptocheirus plumulosus* survival, growth, and reproduction tests and 20-day *Neanthes arenaceodentata* survival and growth tests. The *Leptocheirus plumulosus* tests were conducted in accordance with EPA Method 600/R01-020: *Methods for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-Associated Contaminants with the Amphipod, Leptocheirus plumulosus* (USEPA, 2001a), while the *Neanthes arenaceodentata* toxicity tests were conducted in accordance with ASTM Standard E 1562-00: *Standard Guide for Conducting Acute, Chronic, and Life-Cycle Aquatic Toxicity Tests with Polychaetous Annelids* (ASTM, 2006b). Test endpoints for *Leptocheirus plumulosus* were survival, calculated as the percentage of neonates at test initiation that survive as adults at test termination; growth, calculated as dry weight per surviving adult amphipod at test termination, and reproduction, calculated as juvenile production per surviving adult amphipod at test termination. Test endpoints for *Neanthes arenaceodentata* were survival, calculated as the percentage of polychaetes at test initiation that survive at test termination, and growth, calculated as dry weight per surviving polychaete at test termination.

For each SWMU 2 and estuarine wetland reference area sediment sample, *Leptocheirus plumulosus* was tested using eight replicate containers, with twenty amphipods per replicate (160 amphipods per sample), while *Neanthes arenaceodentata* was tested using eight replicates, with 10 polychaetes per replicate (80 polychaetes per sample). EPA Method 600/R01-020 and ASTM Standard E 1562-00 specify the acceptable laboratory control performance criteria and testing procedures for the *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity tests, respectively. The testing laboratory's SOW (Appendix B) also specifies acceptable laboratory control performance and testing procedures for both species. The laboratory control data indicate that amphipod and polychaete performance exceeded the minimum acceptability criteria specified by EPA Method 600/R01-020 and ASTM Standard E 1562-00 (control survival greater than or equal to 80 percent). Furthermore, no protocol deviations were observed or recorded during the performance of the toxicity tests. The toxicity test report summarizing the toxicity evaluations using *Leptocheirus plumulosus* and *Neanthes arenaceodentata* is included as Appendix E. The results of the toxicity tests are presented and discussed in Sections 4.2.5 (*Leptocheirus plumulosus*) and 4.2.6 (*Neanthes arenaceodentata*).

3.2.6 Fiddler Crab Tissue Sampling

Fiddler crab tissue samples were collected from the estuarine wetland system downgradient from the SWMU 2. The estuarine coastline, between historical sample location 2EWS18 and 2EWS04 was divided into four segments of approximate equal length based on linear feet of coast line (Figure 3-11). These historical sampling locations form the southwestern and northeastern boundary of potentially impacted wetland sediments as determined by copper, lead, and zinc analytical data from the 2003 and 2004 additional data collection investigations (see Table 2-10). Two fiddler crab composite samples were collected from each segment and analyzed for lead, mercury, and percent

lipids using the methods presented in Table 3-6. Tissue samples 2B-FC01 and 2B-FC02 were collected from Wetland Segment No. 1, 2B-FC03 and 2B-FC04 were collected from Wetland Segment No. 3, 2B-FC05 and 2B-FC06 were collected from Wetland Segment No. 2, and 2B-FC07 and 2B-FC08 were collected from Wetland Segment No. 1. A given composite sample consisted of six individual whole-body crabs randomly collected within the assigned segment. Fiddler crabs were rinsed with laboratory-grade deionized water to remove sediment. After rinsing, the fiddler crab samples were frozen in a freezer overnight, packed on ice, and shipped to the analytical laboratory (STL-Savannah). Ingesta were not purged prior to freezing.

In addition to the SWMU 2 fiddler crab tissue sampling, a total of four fiddler crab composite samples were collected from the estuarine wetland reference area (in the vicinity of sediment sample locations for analytical and toxicity testing). Reference area fiddler crab tissue samples were labeled 2B-REF-FC01 through 2B-REF-FC04. Identical to the SWMU 2 tissue samples, each fiddler crab tissue sample consisted of six individual whole-body crabs randomly collected throughout the reference area, prepared and shipped to the analytical laboratory in the same manner as the SWMU 2 samples. The results of the fiddler crab tissue analyses are presented and discussed in Section 4.2.7.

3.2.7 Seagrass Tissue and Co-Located Sediment Sampling

Foraging studies indicate that manatees in the off-shore environment at NAPR feed by either selective grazing of above ground shoots and stems or by feeding on the entire plant, including roots and rhizomes (Geo-Marine Inc., 2005, Reid et al., 2001, and Mignucci-Giannoni and Beck, 1998). For this reason, both above ground and whole-plant seagrass composite samples were collected from the open water habitat at SWMU 2. As turtle grass is the dominant submerged aquatic vegetation within the Ensenada Honda (Reid et al., 2001) and West Indian manatees preferentially feed on turtle grass, even when it is not the dominant species, this species was targeted for seagrass sampling.

Table 3-5 includes a sampling summary of the turtle grass tissue samples collected at SWMU 2. As evidenced by Table 3-5, a total of six composite tissue samples were collected from three locations within the open water portion of SWMU 2 (one above ground composite sample and one whole-plant composite sample per sample location). As the ecological COCs identified in Step 3a of the BERA for West Indian manatee dietary exposures (i.e., arsenic, cadmium, copper, lead, mercury, selenium, and zinc) exhibited a fairly uniform concentration distribution throughout the open water portion of SWMU 2 (see Table 2-13), specific locations were not targeted for sampling based on analytical chemistry. Instead, sample locations (depicted on Figure 3-12) were selected in the field based on the presence of turtle grass. It is noted that the turtle grass sampling locations depicted on Figure 3-12 are approximate locations due to GPS malfunction in the field at the time of sampling. Turtle grass sample locations were approximated by marking a map in the field, using the shoreline as a reference point.

The composite turtle grass tissue samples were designated 2B-SG01-AG, 2B-SG01-WP, 2B-SG02-AG, 2B-SG02-WP, 2B-SG03-AG, and 2B-SG03-WP. Samples with the “AG” designation within the sample identification correspond to the above ground tissue samples, while samples with the “WP” designation correspond to the whole-plant tissue samples. All samples were collected from shallow water less than two meters in depth, as this depth represents prime foraging habitat for West Indian manatees. Water depths greater than two meters are generally used for resting and traveling rather than for foraging (Reid et al., 2001). Above ground composite samples were collected by shearing the plants at the sediment-water interface, while whole-plant composite samples were collected using a shovel. For a given sample location and type (i.e., above ground or whole-plant), a sufficient volume of plant material was collected to fill a one-gallon freezer bag. Prior to distribution to the freezer bags, plant material was rinsed with potable water and laboratory-grade deionized water to

remove any sediment. After rinsing, the sea grass samples were frozen in a freezer overnight, packed on ice, and shipped to the analytical laboratory (STL-Savannah). Each turtle grass tissue sample was analyzed for arsenic, cadmium, copper, lead, mercury, selenium, and zinc on a standard turn (i.e., 28 days) using the methodology summarized in Table 3-6.

A single sediment sample was collected from the 0.0 to 0.5-foot depth interval at each SWMU 2 turtle grass sampling location using dedicated sediment core liners. The co-located open water sediment samples were designated 2B-OWSD01 through 2B-OWSD03. Sample designations correspond to their co-located turtle grass samples. For example, 2B-OWSD01 represents the sediment sample co-located with turtle grass samples 2B-SG01-AG and 2B-SG01-WP. Each co-located sediment sample was analyzed for arsenic, cadmium, copper, lead, mercury, selenium, zinc, TOC, grain size using the methodology summarized in Table 3-6. Analytical data were evaluated to determine if the turtle grass tissue samples were collected from areas representative of the range of sediment concentrations observed within the open water portion of SWMU 2 during the 2003 additional data collection field investigation. The evaluation is presented in Section 4.2.8.1.

In addition to the SWMU 2 turtle grass and sediment samples, three above ground and three whole-plant turtle grass tissue samples (designated REF2-VEG-AB01, REF2-VEG-WB01, REF2-VEG-AB02, REF2-VEG-WB02, REF2-VEG-AB03, and REF2-VEG-WB03), as well as three sediment samples (designated REF2-VEG-SED01, REF2-VEG-SED02, and REF2-VEG-SED03) were collected from Open Water Reference Area No. 2 during the BERA field investigation at SWMU 45 (Baker 2008a; see Table 3-7 and Figure 3-13). Turtle grass samples with the “AG” designation within the sample identification correspond to the above ground tissue samples, while samples with the “WB” designation correspond to the whole-plant tissue samples. Identical to sediment samples collected at SWMU 2, the Open Water Reference Area No. 2 sediment samples were co-located with the turtle grass samples (e.g., REF2-VEG-SED01 represents the open water reference area sediment sample co-located with turtle grass tissue samples REF2-VEG-AB01 and REF2-VEG-WB01). Although the reference area turtle grass and co-located sediment samples were collected during the SWMU 45 BERA field investigation, each sample was analyzed for the ecological COCs unique to SWMU 2 West Indian manatee dietary exposures (i.e., arsenic, cadmium, copper, lead, mercury, selenium, and zinc). This approach, outlined in the Final Step 3b and 4 Report for SWMUs 1 and 2 (Baker, 2007), was used to avoid re-sampling of Reference Area No. 2 during the BERA field sampling activities at SWMU 2. In addition to arsenic, cadmium, copper, mercury, selenium, and zinc, reference area sediment samples were analyzed for TOC and grain size. Analyses were performed in accordance with the methodology summarized in Table 3-6.

3.3 Quality Assurance/Quality Control Sampling

QA/QC samples were collected to: (1) ensure that dedicated sampling equipment was free of contamination (equipment rinsate blanks); (2) evaluate field methodologies (duplicate samples); (3) establish field background conditions (field blanks); and (4) evaluate laboratory processes by analyzing and comparing matrix spike/matrix spike duplicate (MS/MSD) samples. QA/QC samples collected during verification of the BERA field sampling design and BERA field investigation are summarized in Tables 3-1 and 3-5, respectively.

3.4 Data Evaluation and Validation

Analytical data generated during BERA field activities (field verification of the sampling design and BERA field investigation) are presented and discussed in Section 4.0. The analytical data were subjected to independent, third party data validation. Copies of the data validation narratives provided by the data validators (Environmental Data Quality Inc. of Exton, Pennsylvania, DataQual

Environmental Services, LLC of St. Louis, Missouri, and Environmental Data Services, Inc. of Williamsburg, Virginia) are included as Appendix F. Definitions of data qualifiers used by the data validators are summarized in Table 3-8. The validation was performed in accordance with USEPA Region II Standard Operating Procedure (SOP) HW-22, Revision 2 (USEPA, 2001b), USEPA Region II SOP HW-23, Revision 0 (USEPA, 1995), and USEPA Region II SOP HW-2, Revision 13 (USEPA, 2005e) for the PAH, organochlorine pesticide, and inorganic (metals, AVS, SEM, sulfide, ammonia, pH, and TOC) data, respectively. The criteria used to evaluate the analytical data included: data completeness, technical holding times, initial and continuing calibrations, Contract Required Detection Limit (CRDL) standards, interference check samples, blanks (e.g., method, field, and equipment blanks), laboratory control samples, MS recoveries, MSD relative percent differences (RPDs), post digestion spike recoveries, serial dilutions, field duplicates, and identification/quantitation. The sections that follow identify the Sample Delivery Groups (SDGs) associated with field verification and BERA field investigation analytical results. Specific analytical and data quality problems that resulted in data qualification actions are summarized within the data validation narratives (see Appendix F).

3.4.1 Verification of BERA Field Sampling Design

Surface and subsurface soil samples were collected from the upland habitat at SWMU 2 and from three upland reference areas during verification of the field sampling design. Step 5 sampling activities also included the collection of sediment from the estuarine wetland adjacent to SWMU 2 and the estuarine wetland reference area. Sampling activities associated with verification of the field sampling design at SWMU 2 were conducted from February 27 to March 1, 2007. Samples were analyzed by STL-Savannah and analytical results are reported within SDGs SWMU24740-1, SWMU24740-2, and SWMU24740-3. Analytical and data quality problems associated with these three SDGs were identified by DataQual Environmental Services, LCC. Appendix F includes a data validation narrative for SDG PRN20478. This SDG contains analytical data for open water reference area sediment samples collected during verification of the field sampling design at SWMU 45. The open water reference area sediment samples were collected on September 20 and September 21, 2006 and analyzed by STL-Savannah. Analytical and data quality problems associated with SDG PRN20478 were identified by DataQual Environmental Services, LCC. This SDG is included within Appendix F because the field verification analytical data for the open water reference area sediment samples are relevant to SWMU 2 (i.e., analytical data were evaluated in order to determine an appropriate reference area for the collection of turtle grass during the BERA field investigation at SWMU 2).

The specific analytical data associated with SDGs SWMU24740-1, SWMU24740-2, SWMU24740-3, and PRN20478 are summarized below.

- SDG SWMU24740-1: SDG SWMU24740-1 is relevant to the pH and TOC analytical results for SWMU 2 surface soil samples (2V-SS01 through 2V-SS06) and SWMU 2 subsurface soil samples (2V-SB01 through 2B-SB06). This SDG also is relevant to the ammonia and sulfide analytical results for SWMU 2 estuarine wetland sediment samples (2V-EWSD01 through 2V-EWSD06).
- SDG SWMU24740-2: SDG SWMU24740-2 is relevant to the PAH, organochlorine pesticide, metal, pH, and TOC analytical results for upland reference area surface soil samples (REF-SS01 through REF-SS12), upland reference area subsurface soil samples (REF-SB01 through REF-SB12), and any associated field QA/QC samples (i.e., field duplicates and MS/MSD samples). This SDG also is relevant to the metal (copper, lead, mercury, and zinc), ammonia, sulfide, TOC, and pH analytical results for estuarine wetland

reference area sediment samples (REF-EWSD01 through REF-EWSD01), including any associated field QA/QC samples.

- SDG SWMU24740-3: SDG SWMU24740-3 is relevant to the PAH, organochlorine pesticide, and/or metal analytical results for three equipment rinsate blanks (1V-ER01 and REF-ER01 [each collected from stainless steel spoons] and 2V-ER02 [collected from a stainless steel bucket auger]) and one field blank ([1V-FB01 [laboratory-grade deionized water]]).
- SDG PRN20478: SDG PRN20478 is relevant to the arsenic, cadmium, copper, lead, mercury, selenium, and zinc analytical results for sediment samples collected from Open Water Reference Area Nos. 1, 2, and 3 during verification of the field sampling design at SWMU 45 and any associated field QA/QC samples (i.e., field duplicates and MA/MSD samples). This SDG includes analytical data for one equipment rinsate blank (45B-ER01V [collected from a sediment core liner]) and one field blank (45B-FB01V [laboratory-grade deionized water]).

3.4.2 BERA Field Investigation

Surface and subsurface soil samples were collected at SWMU 2 and Upland Reference Area No. 2 during the BERA field investigation conducted May 18, 2007 to May 22, 2007. Sediment and fiddler crab tissue also were collected from the estuarine wetland adjacent to SWMU 2 and the estuarine wetland reference area. In addition, sediment and sea grass tissue were collected from the open water portion of SWMU 2. Finally, earthworm tissue was collected from toxicity test chambers following a 28-day exposure to SWMU 2 soil. Laboratory analyses were performed by STL and reported within SDGs C7E220126 (STL-Pittsburgh), 580-5970-1 (STL-Seattle), SWMU26880-1 (STL-Savannah), 680-26880-2 (STL-Savannah), SWMU27044 (STL-Savannah), SWMU26980 (STL-Savannah), SWMU28224-1 (STL-Savannah), SWMU680-23902-1 (STL-Savannah), 680-23974-1 (STL-Savannah). Analytical and data quality problems identified by the data validators (Environmental Data Quality, Inc. and DataQual Environmental Services, LLC) that resulted in data qualification actions are summarized within the data validation narratives included as Appendix F. Appendix F includes data validation narratives for two SDGs that contain analytical data for sediment and turtle grass tissue samples collected from Open Water Reference Area No. 2 during the BERA field investigation at SWMU 45 (see Baker, 2008a and Section 3.2.3). Laboratory analyses were performed by STL Savannah and reported within SDGs 680-23902-1 (sediment analytical data) and SDG 680-23974-1 (turtle grass tissue analytical data).

The specific analytical data associated with SDGs C7E220126, SDG 580-5970-1, SWMU26880-1, SWMU26880-2, SWMU27044, SWMU26980, SWMU28224-1, 680-23902-1, and 680-23974-1 is summarized below.

- SDG C7E220126: SDG C7E220126 is relevant to the antimony, copper, lead, mercury, and zinc analytical results for quick-turn SWMU 2 surface soil samples 2B-SS01 through 2B-SS23 and 2B-SS25 through 2B-SS38. This SDG also includes any associated field QA/QC samples (i.e., field duplicates and MS/MSD samples).
- SDG 580-5970-1: SDG 580-5970-1 is relevant to the antimony, copper, lead, mercury, and zinc analytical results for quick-turn SWMU 2 surface soil samples 2B-SS24 and 2B-SS39 through 2B-SS50, quick-turn SWMU 2 subsurface soil samples (2B-SB01-01, 2B-SB02-01, 2B-SB04-01, and 2B-SB06-01 through 2B-SB10-01), quick-turn Upland Reference Area No. 2 surface soil samples soil samples 2B-REF-SS01 through 2B-REF-SS06, and quick-turn

Upland Reference Area No. 2 subsurface soil samples 2B-REF-SB-1-01 through 2B-REF-SB06-01. This SDG also includes any associated field QA/QC samples (i.e., field duplicates and MS/MSD samples).

- SDG SWMU26880-1: SDG SWMU26880-1 is relevant to the copper, lead, mercury, and zinc analytical results for quick-turn SWMU 2 estuarine wetland sediment samples 2B-EWSD01 through 2B-EWSD03 and 2B-EWSD05 through 2B-EWSD07, quick-turn estuarine wetland reference area sediment samples 2B-REF-EWSD02 through 2B-REF-EWSD06, and any associated field QA/QC samples (i.e., field duplicates and MS/MSD samples).
- SDG SWMU26880-2: SDG 680-26880-2 is relevant to the copper, lead, mercury, and zinc analytical results for quick-turn SWMU 2 estuarine wetland sediment samples 2B-EWSD04, 2B-EWSD08 through 2B-EWSD16, and 2B-EWSD18 through 2B-EWSD24, quick-turn estuarine wetland reference area sediment sample 2B-REF-EWSD01, and any associated field QA/QC samples (i.e., field duplicates samples and MS/MSD samples).
- SDG SWMU27044: SDG SWMU27044 is relevant to the pH, TOC, and grain size analytical results for SWMU 2 and Upland Reference Area No. 2 soil samples submitted for *Eisenia fetida* toxicity testing (2B-SS04, 2B-SS04-01, 2B-SS05, 2B-SS10, 2B-SS13, 2B-SS14, 2B-SS31, 2B-SS33, 2B-SS34, 2B-SS41, 2B-SS44, 2B-SS49, 2B-REF-SB01-01, 2B-REF-SB04, and 2B-REF-SS05) and the AVS, SEM, pH, TOC, total ammonia, sulfide and grain size analytical results for SWMU 2 and estuarine wetland reference area sediment samples submitted to the toxicity testing laboratory for *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity testing (2B-EWSD-04, 2B-EWSD-09, 2B-EWSD-12, 2B-EWSD-15, 2B-EWSD-16, 2B-EWSD-18, 2B-EWSD-20, and 2B-EWSD-24, 2B-REF-EWSD-01, and 2B-REF-EWSD-02). This SDG also includes associated field QA/QC samples.
- SDG SWMU26980: SDG SWMU26980 is relevant to the arsenic, cadmium, copper, lead, mercury, selenium, and zinc analytical results for SWMU 2 open water sediment samples (2B-OWSD01 through 2B-OWSD03) and turtle grass tissue samples (2B-SG01-AG through 2B-SG03-AG and 2B-SG01-WP through 2B-SG03-WP). In addition, this SDG is relevant to the mercury, zinc, and percent lipids analytical results for SWMU 2 fiddler crab tissue samples (2B-FC01 through 2B-FC08) and estuarine wetland reference area fiddler crab tissue samples (2B-REF-FC01 through 2B-REF-FC04), as well as the antimony, arsenic, cadmium, copper, lead, mercury, selenium, and zinc analytical results for three equipment rinsate blanks (2B-ER01 [collected from a stainless steel spoon], 2B-ER02 [collected from a stainless steel bucket auger], and 2B-ER03 [collected from an aluminum pan]) and two field blanks (2B-FB01 [laboratory-grade deionized water] and 2B-FB02 [potable water]). Finally, this SDG includes any associated field QA/QC samples (field duplicate and MS/MSD samples).
- SDG SWMU28224-1: SDG SWMU28224-1 is relevant to the antimony, copper, lead, mercury, zinc, and percent lipids analytical results for earthworm tissue samples collected from toxicity test chambers following a 28-day exposure period to SWMU 2 and Upland Reference Area No. 2 soil (2B-SS04, 2B-SS04-01, 2B-SS05, 2B-SS10, 2B-SS13, 2B-SS14, 2B-SS31, 2B-SS33, 2B-SS34, 2B-SS41, 2B-SS44, 2B-SS49, 2B-REF-SB01-01, 2B-REF-SB04, and 2B-REF-SS05).
- SDG 680-23902-1: SDG 680-23902-1 is relevant to the arsenic, cadmium, copper, lead, mercury, selenium, and zinc analytical results for Open Water Reference Area No. 2

sediment samples (REF2-VEG-SED01 through REF2-VEG-SED03). The open water reference area sediment samples were co-located with the open water reference area turtle grass tissue samples reported in SDG 680-23974-1. Arsenic, cadmium, selenium, and mercury analytical results were validated by Environmental Data Services, Inc. while copper, lead and zinc analytical results were validated by DataQual Environmental Services, LLC. The arsenic, cadmium, copper, mercury, selenium, and zinc analytical results for the open water reference area sediment samples and the data validation narrative for SDG 680-23902-1 were previously presented in the Final Steps 6 and 7 Report for SWMU 45 (Baker, 2008b) and/or the Draft Steps 6 and 7 Report for SWMU 1 (Baker, 2008c). Because this information also is relevant to SWMU 2, the data validation narrative for SDG 680-23902-1 is included within Appendix F of this report.

- SDG 680-23974-1: SDG 680-23974-1 is relevant to the arsenic, cadmium, copper, lead, mercury, selenium and zinc analytical results for Open Water Reference Area No. 2 turtle grass tissue samples (REF2-VEG-AB01 through REF2-VEG-AB03 and REF2-VEG-WB01 through REF2-VEG-WB03). The open water reference area turtle grass tissue samples were co-located with the open water reference area sediment samples reported in SDG 680-23902-1. Arsenic, cadmium, selenium, and mercury analytical results were validated by Environmental Data Services, Inc, while copper, lead and zinc analytical results were validated by DataQual Environmental Services, LLC. The arsenic, cadmium, copper, mercury, selenium, and zinc analytical results and the open water reference area turtle grass tissue samples and the data validation narrative for this SDG 680-23974-1 were previously presented in the Final Steps 6 and 7 Report for SWMU 45 (Baker, 2008b) and/or the Draft Steps 6 and 7 Report for SWMU 1 (Baker, 2008c). Because this information also is relevant to SWMU 2, the data validation narrative for SDG 680-23902-1 is included within Appendix F of this report.

3.4.3 Validation Summary

The DCQAP (Baker, 1995) states that, *“For completeness, it is expected that methodology proposed for chemical characterization of the samples will meet QC acceptance criteria for at least 95% of all sample data.”* As no field verification (Step 5) and BERA (STEP 6) analytical data were rejected during data validation activities, the percent completeness objectives for each ecological COC-media combination were met.

4.0 ANALYTICAL AND TOXICITY TEST RESULTS AND DATA ANALYSIS

Step 6 of the ERA process is the Site Investigation and Analysis Phase. The site investigation was conducted as outlined in Section 3.0. This section presents the surface soil, subsurface soil, sediment (estuarine wetland and open water sediment), earthworm tissue, fiddler crab tissue, and turtle grass tissue analytical data, earthworm, amphipod, and polychaete toxicity test results, and dietary intake modeling results (terrestrial avian omnivore [American robin], estuarine wetland avian invertivore [spotted sandpiper], and West Indian manatee) for the BERA at SWMU 2.

4.1 Verification of BERA Field Sampling Design

Prior to mobilization for the BERA field investigation (Step 6), the field sampling design was verified in the field to ensure that the BERA study design was appropriate and could be implemented at SWMU 2. As discussed in Section 3.1, a primary objective of the verification of the BERA field sampling design was the identification of appropriate upland, estuarine wetland, and open water reference areas. To meet this objective, potential upland, estuarine, and open water reference areas (see Figure 3-1) were evaluated in Step 5 of the ERA process (verification of the BERA field Sampling Design). The evaluation of each reference area (upland, estuarine wetland, and open water) is presented within the sections that follow.

4.1.1 Upland Reference Areas

Surface and subsurface soil were collected at SWMU 2 and three upland reference areas (Upland Reference Area No. 1, Upland Reference Area No. 2, and Upland Reference Area No. 3) on February 27 and February 28, 2007 during Step 5 of the ERA process. As discussed in Section 3.1, Upland Reference Area No. 1 was established approximately 0.17 miles north of SWMU 2, Upland Reference Area No. 2 was established north of Kearsage Road, between SWMUs 1 and 2 (approximately 0.11 miles north of SWMU 1 and 0.17 miles southwest of SWMU 2), while Upland Reference Area No. 3 was established approximately 0.16 miles south of SWMU 1 (see Figure 3-1).

Table 3-1 provided a summary of the surface and subsurface soil samples collected at SWMU 2 and the upland reference areas. As evidenced by Table 3-1, six surface soil samples and six subsurface soil samples were collected at SWMU 2, while four surface soil samples and four subsurface soil samples were collected at each upland reference area. The SWMU 2 soil samples were analyzed for TOC, pH, and grain size. Two of the four surface and subsurface soil samples collected at each upland reference area were analyzed for the ecological COCs identified in Step 3a of the ERA for terrestrial invertebrate direct contact exposures and terrestrial avian omnivore dietary exposures (i.e., antimony, copper, lead, mercury, and zinc), as well as TOC, pH, and grain size. The remaining two surface and subsurface soil samples collected at each upland reference area were analyzed for PAHs, Appendix IX organochlorine pesticides, Appendix IX metals, TOC, pH, and grain size. Analytical results for surface and subsurface soil collected at SWMU 2 are presented within Tables 4-1 and 4-2, respectively. Analytical results for surface soil collected at Upland Reference Area Nos. 1, 2, and 3 are presented within Tables 4-3, 4-4, and 4-5, respectively, while analytical results for subsurface soil collected at Upland Reference Area Nos. 1, 2, and 3 are presented within Tables 4-6, 4-7, and 4-8, respectively. Analytical data for associated QA/QC field samples (i.e., equipment rinsate and field blanks) are presented in Table 4-9.

The proposed upland reference areas were evaluated based on biological and chemical properties. As outlined in Section 3.1.1, a given reference area was deemed acceptable for use as a source of reference soil for earthworm toxicity testing if the following conditions were met:

- The range of TOC concentrations and grain size characteristics in upland reference area soil are similar to the ranges found in soil located within the study area (SWMU 2 upland habitat).
- Maximum PAH, Appendix IX metal, and Appendix IX organochlorine pesticide concentrations do not exceed the soil screening values listed in Table 3-3 or, in the case of metals, the background surface and subsurface soil screening values established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008a).
- Maximum lead, mercury, and zinc concentrations in upland reference area surface soil and maximum copper, lead, and zinc concentrations in upland reference area subsurface soil do not exceed the background surface and subsurface soil screening values established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (22 mg/kg for lead, 0.109 mg/kg for mercury, and 115 mg/kg for zinc [Baker, 2008a]).

An evaluation of the upland reference areas against these three criteria is presented in the sections that follow.

4.1.1.1 Physical and Chemical Properties of Soil

As discussed in Section 4.1.1, a criterion used to evaluate the suitability of soil at each upland reference area involved the comparison TOC concentrations and grain size characteristics in Upland Reference Area Nos. 1, 2 and 3 surface and subsurface soil samples to TOC concentrations and grain size characteristics in SWMU 2 surface and subsurface soil samples.

4.1.1.1.1 *Surface Soil*

TOC concentrations measured in SWMU 2 surface soil (see Table 4-1) ranged from 24,000 mg/kg (2V-SS01) to 56,000 mg/kg (2V-SS03). Reported TOC concentrations in Upland Reference No. 1 surface soil showed considerable variability (see Table 4-3), with concentrations ranging from 9,400 mg/kg (REF-SS03) to 71,000 mg/kg (REF-SS01), with two values reported at 38,000 mg/kg (REF-SS02 and REF-SS04). TOC concentrations in surface soil collected at Upland Reference Area Nos. 2 and 3 showed lower variability. Upland Reference Area No. 2 TOC concentrations ranged from 9,800 mg/kg (REF-SS06) to 26,000 mg/kg (REF-SS07), while TOC concentrations in Upland Reference Area No. 3 ranged from 13,000 mg/kg (REF-SS09) to 34,000 mg/kg (REF-SS010) (see Tables 4-4 and 4-5, respectively). With the exception of REF-SS10, TOC concentrations in Upland Reference Area No. 3 surface soil samples were less than or equal to 17,000 mg/kg (Table 4-5). The data indicate that TOC concentrations in Upland Reference Area Nos. 2 and 3 surface soils are generally lower than TOC concentrations measured in SWMU 2 and Upland Reference Area No. 1 surface soils.

The particle size distribution data presented in Table 4-1 (SWMU 2) and Tables 4-3 through 4-5 (Upland Reference Area Nos. 1, 2, and 3, respectively) indicate that surface soils collected at Upland Reference Area No. 2 are most similar to SWMU 2 with regard to sand content (10.4 percent to 29.6 percent at SWMU 2, 28.1 percent to 87.7 percent at Upland Reference Area No. 1, 12.5 percent to 21.7 percent at Upland Reference Area No. 2, and 23.2 percent to 37.5 percent at Upland Reference Area No. 3). The silt and clay content of SWMU 2 surface soil was quite variable, ranging from 16.2 percent in 2V-SS04 to 79.3 percent in 2V-SS01). Measured values within this range were 25.9 percent (2V-SS03), 33.1 percent (2V-SS06), 47.0 percent (2V-SS05), and 73.9 percent (2V-SS02). The silt/clay content of Upland Reference Area No. 1 surface soil samples was generally low, ranging

from 7.5 percent in REF-SS03 to 58.2 percent in REF-SS04. Only REF-SS04 had a silt/clay content greater than fifty percent. Surface soil collected at Upland Reference Area Nos. 2 and 3 were generally more finely grained than surface soil collected at SWMU 2. Upland Reference Area No. 2 silt and clay content ranged from 66.5 percent to 84.9 percent, while Upland Reference Area No. 3 values ranged from 44.3 percent to 77.2 percent. The gravel content of surface soil collected at each upland reference area was considerably lower than the gravel content measured in the majority of the SWMU 2 surface soil samples. Soil textural classifications illustrate the differences between SWMU 2 surface soil and Upland Reference Area Nos. 1, 2, and 3 surface soils.

The analytical data presented in Table 4-1 and Tables 4-3 through 4-5 indicate that, in general, Upland Reference Area No. 1 surface soils are most similar to SWMU 2 surface soils with regard to TOC. Although Upland Reference Area No. 1 surface soils showed considerable variability in organic carbon content, the TOC concentration measured in two of four (2/4) samples fall within the range of values measured in SWMU 2 surface soil. This compares to a single sample at Upland Reference Area Nos. 2 and 3. The particle size distribution data and soil textural classifications show that, in general, surface soil collected at each of the upland reference area does not compare well with surface soil collected at SWMU 2. Surface soil samples collected at Upland Reference Area Nos. 2 and 3 were generally more finely grained than SWMU 2 surface soil samples, while surface soil samples collected at Upland Reference Area No. 1 exhibited higher sand content and lower silt/clay content. ASTM (2006a) does not specify acceptable TOC and grain size requirements for *Eisenia fetida*, but states that, “A reference soil should be collected from the field in a clean area and represent the test soil as much as possible in soil characteristics (for example, percent organic matter, particle size distribution, and pH).” Although the TOC content of surface soils collected at Upland Reference Area No. 1 were most similar to SWMU 2, this location was not deemed acceptable for use as a source of surface soil for *Eisenia fetida* toxicity testing based on considerable differences in particle size distributions (lower silt/clay and higher sand content when compared to SWMU 2). Upland reference Area No. 3 also was deemed unacceptable based on considerable differences in TOC content (TOC concentrations in Upland Reference Area No. 3 surface soil samples were generally less than or equal to 17,000 mg/kg, while TOC concentrations in SWMU 2 surface soil samples exceeded 24,000 mg/kg). Although Upland Reference Area No. 2 surface soil samples exhibited lower TOC and higher silt/clay content than SWMU 2, surface soils from this location were deemed most appropriate for *Eisenia fetida* toxicity testing (differences between Upland Reference Area No. 2 and SWMU 2 were not as considerable as differences between Upland Reference Area No. 3 and SWMU 2 TOC content and Upland Reference Area No. 1 and SWMU 2 particle size distributions). Surface soil samples from this reference area also were successfully used in *Eisenia fetida* toxicity tests conducted for a BERA at SWMU 1 (Baker, 2009).

4.1.1.1.2 Subsurface Soil

TOC concentrations measured in SWMU 2 subsurface soil (see Table 4-2) ranged from 7,400 mg/kg (2V-SB06) to 26,000 mg/kg (2V-SB01). With the exception of 2V-SB01, reported TOC concentrations were fairly uniform (7,400 mg/kg in 2V-SB06, 8,100 mg/kg in 2V-SB02, 9,800 mg/kg in 2V-SB03, 15,000 mg/kg in 2V-SB05, and 17,000 mg/kg in 2V-SB04). As evidenced by Tables 4-6 through 4-8, TOC concentrations in Upland Reference No. 1 subsurface soil ranged from 10,000 mg/kg (REF-SB04) to 53,000 mg/kg (REF-SB03), TOC concentrations in Upland Reference Area No. 2 ranged from 6,700 mg/kg to 8,200 mg/kg, and TOC concentrations in Upland Reference Area No. 3 subsurface ranged from 3,400 mg/kg (REF-SB09) to 19,000 mg/kg (REF-SB010). The data indicate the TOC content of Upland Reference Areas No. 1 surface soil is generally higher than the TOC content of SWMU 2 surface soil, while the TOC content of Upland Reference Area No. 2 surface soil is lower. Subsurface soil collected at Upland Reference Area No. 3 was most similar to

SWMU 2. The TOC concentration measured in three of four (3/4) Upland Reference Area No. 3 subsurface soil samples fall within the range of values measured in SWMU 2 surface soil.

The particle size distribution data presented in Table 4-2 and Tables 4-6 through 4-8 indicate that subsurface soil collected at Upland Reference Area Nos. 2 and 3 are most similar to SWMU 2 subsurface soil. This is illustrated by the clay content and soil textural classifications assigned to the SWMU 2 and Upland Reference Area Nos. 2 and 3 subsurface soil samples. Identical to the surface soil data, the sand content of Upland Reference Area No. 1 subsurface soil was generally higher than the sand content of SWMU 2 subsurface soil. The gravel content in SWMU 2 and upland reference area subsurface soils was highly variable. In general, the gravel content of Upland Reference Area No. 3 subsurface soil was lower than the gravel content measured in SWMU 2 and Upland Reference Area Nos. 1 and 2 subsurface soils.

The analytical data presented in Table 4-2 and Tables 4-6 through 4-8 indicate that Upland Reference Area No. 3 subsurface soil is most similar to SWMU 2 subsurface soil with regard to TOC. The analytical data also show that Upland Reference Area Nos. 2 and 3 are most similar to SWMU 2 subsurface soil with regard to particle size distributions. When both subsurface soil characteristics are taken into consideration, Upland Reference Area No. 3 subsurface soil is deemed most appropriate for *Eisenia fetida* toxicity testing.

4.1.1.2 Comparison of Antimony, Copper, Lead, Mercury, and Zinc Analytical Data to Soil Screening Values

As outlined in the final Step 3b and 4 Report (Baker, 2006c) and Sections 3.1 and 4.1.1 herein, a given upland reference area was considered acceptable as a source of soil for *Eisenia fetida* toxicity testing in Step 6 of the BERA if PAHs, organochlorine pesticides, and metals were not detected at concentrations greater than the soil values listed in Table 3-3. A comparison of the upland reference area surface and subsurface soil analytical data to soil screening values is provided in the Sections that follow.

4.1.1.2.1 Upland Reference Area No. 1

Surface Soil

Three PAHs (benzo[b]fluoranthene, fluoranthene, and pyrene) and one pesticide (1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane [4,4'-DDT]) were detected in Upland Reference Area No. 1 surface soil collected during verification of the field sampling design (see Table 4-3). The sum of low molecular weight (LMW) PAHs range from 11.5 microgram per kilogram (µg/kg) in REF-SS01D to 23.7 µg/kg in REF-SS02, while the sum of high molecular weight (HMW) PAHs range from 11.7 µg/kg in REF-SS01D to 24.8 µg/kg in REF-SS02 (reporting limit used for non-detected PAHs). Maximum sums are less than the LMW and HMW PAH screening values listed in Table 3-3 (29,000 µg/kg for LMW PAHs and 18,000 µg/kg for HMW PAHs, respectively [USEPA, 2007d]). 4,4'-DDT was detected in two surface soil samples (0.45J µg/kg in REF-SS01 and 0.87J µg/kg in REF-SS01D). Detected concentrations are less than the soil screening value established for this organochlorine pesticide (401 µg/kg [MHSPE, 2000]). Maximum reporting limits for the non-detected organochlorine pesticides also are less than soil screening values.

Twelve metals (arsenic, barium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, vanadium, and zinc) were detected in Upland Reference Area No. 1 surface soil (see Table 4-3). Maximum detected arsenic, barium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, and zinc concentrations, as well as maximum reporting limits for the non-detected metals (antimony, beryllium, silver, thallium, and tin) are less than soil screening values:

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil Screening Value (mg/kg)
Antimony	0.87UJ	78.0
Arsenic	4.8	18.0
Barium	18J	330
Beryllium	0.13UJ	40.0
Cadmium	0.079J	140
Chromium	9.2	57.0
Cobalt	3.5	13.0
Copper	54	80.0
Lead	8.3	1,700
Mercury	0.068J	0.1
Nickel	3.7	280
Selenium	0.36J	4.1
Silver	0.22UJ	560
Thallium	0.22UJ	1.0
Tin	22UJ	50.0
Zinc	60	120

Vanadium was detected in each Upland Reference Area No. 1 surface soil sample analyzed for this metal (27 mg/kg in REF-SS01 and REF-SS01D and 17J mg/kg in REF-SS02) at a concentration greater than the soil screening value (10 mg/kg; see Table 3-3 for a description of the soil screening value). However, detected concentrations are less than the maximum and ULM background concentration established for surface soils at NAPR (230 mg/kg and 259 mg/kg, respectively [Baker, 2008a]), indicating that vanadium detections in Upland Reference Area No. 1 surface soil are representative of background levels.

Subsurface Soil

No PAHs were detected in Upland Reference Area No. 1 subsurface soil collected during verification of the field sampling design (see Table 4-6). The sum of LMW PAHs (calculated using reporting limits) is 10.6 µg/kg in REF-SB01 and 10.9 µg/kg in REF-SB02, while the sum of HMW PAHs (calculated using reporting limits) is 10.7 µg/kg in REF-SB01 and 11.0 µg/kg in REF-SB02. Maximum sums are less than the LMW and HMW PAH screening values listed in Table 3-3 (29,000 µg/kg for LMW PAHs and 18,000 µg/kg for HMW PAHs, respectively [USEPA, 2007d]). One organochlorine pesticide (4,4'-DDT) was detected in two Upland Reference Area No. 1 subsurface soil samples (1.5J µg/kg in REF-SB01 and 4.1 µg/kg in REF-SB02). Detected concentrations are less than the soil screening value established for this organochlorine pesticide (401 µg/kg [MHSPE, 2000]). Maximum reporting limits for the non-detected organochlorine pesticides also are less than soil screening values.

Thirteen metals (arsenic, barium, beryllium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, vanadium, and zinc) were detected in Upland Reference Area No. 1 subsurface soil (see Table 4-6). Maximum detected arsenic, barium, beryllium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, and zinc concentrations, as well as maximum reporting limits for the non-detected metals (antimony, silver, thallium, and tin) are less than soil screening values:

Chemical	Maximum Subsurface Soil Concentration (mg/kg)	Soil Screening Value (mg/kg)
Antimony	0.47U	78.0
Arsenic	4.5	18.0
Barium	13	330
Beryllium	0.065J	40.0
Cadmium	0.058J	140
Chromium	6.8J	57.0
Cobalt	4.1	13.0
Copper	58J	80.0
Lead	2.6	1,700
Mercury	0.039	0.1
Nickel	4	280
Selenium	0.21J	4.1
Silver	0.1U	560
Thallium	0.1U	1.0
Tin	10U	50.0
Zinc	44	120

Vanadium was detected in each Upland Reference Area No. 1 subsurface soil sample analyzed for this metal (38J mg/kg in REF-SB01 and 15J mg/kg in REF-SB02) at a concentration greater than the soil screening value (10 mg/kg). However, detected concentrations are less than the maximum and ULM background concentration established for clay subsurface soils at NAPR (410 mg/kg and 434 mg/kg, respectively [Baker, 2008a]), as well as the maximum and ULM background concentration established for fine sand/silt subsurface soils at NAPR (232 mg/kg and 256 mg/kg, respectively [Baker, 2008a]), indicating that vanadium detections in Upland Reference Area No. 1 subsurface soil are representative of background levels.

4.1.1.2.2 Upland Reference Area No. 2

Surface Soil

Nine PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene) and two organochlorine pesticides (1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethylene [4,4'-DDD] and 4,4'-DDT) were detected in Upland Reference Area No. 2 surface soil (see Table 4-4). The sum of LMW PAHs (18 µg/kg in REF-SS05 and 18.1µg/kg in REF-SS06 [reporting limit used for non-detected LMW PAHs]) and HMW PAHs (24.7 µg/kg in REF-SS05 and 27.8 µg/kg in REF-SS06 [reporting limit used for non-detected HMW PAHs]) are less than the LMW and HMW PAH soil screening values listed in Table 3-3 (29,000 µg/kg for LMW PAHs and 18,000 µg/kg for HMW PAHs [USEPA, 2007d]). 4,4'-DDD and 4,4'-DDT were each detected in one surface soil sample (4,4'-DDD: 0.62J µg/kg in REF-SS05; 4,4'-DDT: 5.5J µg/kg in REF-SS05). Detected concentrations are less than the soil screening value established for these two organochlorine pesticides (401 µg/kg [MHSPE, 2000]). Maximum reporting limits for the non-detected organochlorine pesticides also are less than soil screening values.

Thirteen metals were detected in Upland Reference Area No. 2 surface soil (arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, vanadium, and zinc). Maximum detected arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, selenium,

and zinc, as well as maximum reporting limits for the non-detected metals (i.e., antimony, silver, thallium, and tin) are less than soil screening values:

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil Screening Value (mg/kg)
Antimony	0.52U	78.0
Arsenic	3.3	18.0
Barium	110J	330
Beryllium	0.32	40.0
Cadmium	0.15J	140
Chromium	35	57.0
Lead	12	1,700
Mercury	0.057	0.1
Nickel	28	280
Selenium	0.67J	4.1
Silver	0.13U	560
Thallium	0.13U	1.0
Tin	13U	50.0
Zinc	65	120

Cobalt, copper, and vanadium were detected in each Upland Reference Area No. 2 surface soil sample analyzed for these metals at concentrations greater than soil screening values. However, maximum detected concentrations (33 mg/kg for cobalt, 110 mg/kg for copper, and 180 mg/kg for vanadium) are less than maximum and ULM background concentrations established for surface soils at NAPR (maximum background concentrations: 50.2J mg/kg for cobalt, 180 mg/kg for copper, and 230 mg/kg for vanadium; ULM background concentrations (46.2 mg/kg for cobalt, 168 mg/kg for copper, and 259 mg/kg for vanadium [Baker, 2008a]), indicating that detections in Upland Reference Area No. 2 surface soil are representative of background levels.

Subsurface Soil

PAHs were not detected in Upland Reference Area No. 2 subsurface soil sample REF-SB06 (see Table 4-7). The sum of LMW PAHs in this subsurface soil sample (calculated using reporting limits) is 13.4 µg/kg, while the sum of HMW PAHs (calculated using reporting limits) is 13.6 µg/kg. Maximum sums are less than the LMW and HMW PAH screening values listed in Table 3-3 (29,000 µg/kg for LMW PAHs and 18,000 µg/kg for HMW PAHs, respectively [USEPA, 2007d]). Two organochlorine pesticides (4,4'-DDD and 4,4'-DDT) were detected in the REF-SB06 subsurface soil sample. Detected concentrations (0.94J µg/kg for 4,4'-DDD and 6.4 µg/kg for 4,4'-DDT) are less than the soil screening value established for these two organochlorine pesticides (401 µg/kg [MHSPE, 2000]). Maximum reporting limits for the non-detected organochlorine pesticides in subsurface soil sample REF-SB06 also are less than soil screening values.

Thirteen metals were detected in Upland Reference Area No. 2 subsurface soil (arsenic, barium, beryllium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, vanadium, and zinc; see Table 4-7). Maximum detected arsenic, barium, beryllium, cadmium, copper, lead, mercury, nickel, selenium, and zinc, as well as maximum reporting limits for the non-detected metals (i.e., antimony, silver, thallium, and tin) are less than soil screening values:

Chemical	Maximum Subsurface Soil Concentration (mg/kg)	Soil Screening Value (mg/kg)
Antimony	0.51U	78.0
Arsenic	1.9	18.0
Barium	120J	330
Beryllium	0.39	40.0
Cadmium	0.12J	140
Copper	77J	80
Lead	13	1,700
Mercury	0.043	0.1
Nickel	190	280
Selenium	0.58J	4.1
Silver	0.13U	560
Thallium	0.13U	1.0
Tin	13U	50.0
Zinc	59J	120

Chromium, cobalt, and vanadium were detected in the single Upland Reference Area No. 2 subsurface soil sample analyzed for these metals (REF-SB06) at concentrations greater than soil screening values. The detected vanadium concentration (240J mg/kg) is less than the maximum and ULM background concentration established for clay subsurface soils at NAPR (410 mg/kg and 434 mg/kg, respectively [Baker (2008a), as well as the ULM background concentration established for fine sand/silt subsurface soils at NAPR (256 mg/kg [Baker, 2008a]), indicating that the vanadium detection in Upland Reference Area No. 2 subsurface soil is representative of background levels. The detected chromium and cobalt concentration in REF-SB06 (410J mg/kg and 51 mg/kg, respectively) exceed maximum and ULM background concentrations established for clay subsurface soils at NAPR (maximum background concentrations: 148J mg/kg for chromium and 33.8 mg/kg for cobalt; ULM background concentrations: 114.5 mg/kg for chromium and 26.9 mg/kg for cobalt [Baker, 2008a]. The detected chromium concentration in REF-SB06 also exceeds the maximum and ULM background concentration established for fine sand/silt subsurface soils at NAPR (52 mg/kg and 47.9 mg/kg, respectively [Baker, 2008a]), while the detected cobalt concentration is less than the fine sand/silt maximum and ULM background concentration (73.4 mg/kg and 63.1 mg/kg, respectively [Baker, 2008a]). Given that soil textural classification assigned to the REF-SB06 subsurface soil sample is “silty clay loam” and detected cobalt and chromium concentrations in this sample exceed maximum and ULM background concentrations established for clay subsurface soils at NAPR, it can be concluded that detected chromium and cobalt concentrations in Upland Reference Area No. 2 subsurface soil are elevated above background levels.

4.1.1.2.3 Upland Reference Area No. 3

Surface Soil

PAHs were not detected in surface soil collected at Upland Reference Area No. 3 (see Table 4-5). The maximum sum of LMW and HMW weight PAH concentrations calculated using reporting limits (12.4 µg/kg and 12.6 µg/kg, respectively in REF-SS010) are less than soil screening values listed in Table 3-3 (29,000 µg/kg for LMW PAHs and 18,000 µg/kg for HMW PAHs). Organochlorine pesticides were not detected in Upland Reference Area No. 3 surface soil. With the exception of kepone and toxaphene, reporting limits for the non-detected organochlorine pesticides are less than

soil screening values. The kepone and toxaphene reporting limits for REF-SS09 (210 µg/kg) exceed the soil screening value established for these organochlorine pesticides (100 µg/kg [Friday 1998]).

Thirteen metals were detected in Upland Reference Area No. 3 surface soil (arsenic, barium, beryllium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, vanadium, and zinc; see Table 4-5). Maximum detected arsenic, barium, beryllium, cadmium, lead, mercury, nickel, selenium, and zinc, as well as maximum reporting limits for the non-detected metals (i.e., antimony, silver, thallium, and tin) are less than soil screening values:

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil Screening Value (mg/kg)
Antimony	0.46U	78.0
Arsenic	1.1	18.0
Barium	240J	330
Beryllium	0.35	40.0
Cadmium	0.095J	140
Lead	8.3	1,700
Mercury	0.061	0.1
Nickel	17	280
Selenium	1.2	4.1
Silver	0.11U	560
Thallium	0.11U	1.0
Tin	11U	50.0
Zinc	120	120

Cobalt and vanadium were detected in each Upland Reference Area No. 3 surface soil sample analyzed for these metals at concentrations greater than soil screening values (13 mg/kg for cobalt and 10 mg/kg for vanadium). In addition, copper was detected in two surface soil samples (100 mg/kg in REF-SS09 and 110 mg/kg in REF-SS010) and chromium was detected in a single surface soil sample (58 mg/kg in REF-SS09) at concentrations greater than soil screening values (80 mg/kg for copper and 57 mg/kg for chromium). Maximum detected cobalt and copper concentrations (30 mg/kg and 110 mg/kg, respectively) are less than maximum and ULM background concentrations established for surface soils at NAPR (maximum background concentrations: 50.2 mg/kg for cobalt and 180 mg/kg for copper; ULM background concentrations: 46.2 mg/kg for cobalt and 168 mg/kg for copper [Baker, 2008a]), indicating that cobalt and copper detections in Upland Reference Area No. 3 surface soil are representative of background levels. The vanadium detection in REF-SS09 (260 mg/kg) and the chromium detection in REF-SS09 (58 mg/kg) exceed maximum background and ULM background concentrations established for surface soil (maximum background concentrations: 47 mg/kg for chromium and 230 mg/kg for vanadium; ULM background concentrations: 49.8 mg/kg for chromium and 259 mg/kg for vanadium [Baker, 2008b]). These data indicate that chromium and vanadium detection in Upland Reference Area No. 3 surface soils are elevated above background concentrations.

Subsurface Soil

PAHs were not detected in subsurface soil collected at Upland Reference Area No. 3 (see Table 4-8). The maximum sum of LMW and HMW weight PAH concentrations using reporting limits (13.1 µg/kg and 13.18 µg/kg, respectively in REF-SB010) are less than soil screening values listed in Table 3-3 (29,000 µg/kg for LMW PAHs and 18,000 µg/kg for HMW PAHs). 4,4'-DDT was detected in a

single subsurface soil sample (3.9J µg/kg in REF-SB10). This detected concentration is less than the soil screening value established for this organochlorine pesticide (401 µg/kg [MHSPE, 2000]). With the exception of kepone and toxaphene, reporting limits for the non-detected organochlorine pesticides also are less than soil screening values. The kepone and toxaphene reporting limits for REF-SB010 (200 µg/kg) exceed the soil screening value established for these organochlorine pesticides (100 µg/kg [Friday 1998]).

Fourteen metals were detected in Upland Reference Area No. 3 subsurface soil (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt copper, lead, mercury, nickel, selenium, vanadium, and zinc; see Table 4-8). Maximum detected antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, selenium, and zinc, as well as maximum reporting limits for the non-detected metals (i.e., silver, thallium, and tin) are less than soil screening values:

Chemical	Maximum Subsurface Soil Concentration (mg/kg)	Soil Screening Value (mg/kg)
Antimony	24	78.0
Arsenic	1.1	18.0
Barium	260J	330
Beryllium	0.38	40.0
Cadmium	0.071J	140
Chromium	56	57.0
Lead	6	1,700
Mercury	0.04	0.1
Nickel	17	280
Selenium	0.86J	4.1
Silver	0.12U	560
Thallium	0.12U	1.0
Tin	12U	50.0
Zinc	65	120

Cobalt and vanadium were detected in each Upland Reference Area No. 3 subsurface soil sample analyzed for these metals at concentrations greater than soil screening values (13 mg/kg for cobalt and 10 mg/kg for vanadium). Detected cobalt concentrations greater than the soil screening value are 28 mg/kg in REF-SB09 and 50 mg/kg in REF-SB10, while detected vanadium concentrations greater than the soil screening value are 230 mg/kg in REF-SB09 and 250 mg/kg in REF-SB10. In addition, copper was detected in two of four (2/4) subsurface soil samples (98 mg/kg in REF-SB09 and 88 mg/kg in REF-SB10) at concentrations greater than the soil screening value listed in Table 3-3 for this metal (80 mg/kg). Detected copper and vanadium concentrations are less than maximum and ULM background concentrations established for clay subsurface soils at NAPR (maximum background concentrations: 260J mg/kg for copper and 410 mg/kg for vanadium; ULM background concentrations: 246 mg/kg for copper and 434 mg/kg for vanadium [Baker, 2008a]). Detected copper concentrations in Upland Reference Area No. 3 subsurface also are less than the maximum and ULM background concentration established for fine sand/silt subsurface soil (131 mg/kg and 120 mg/kg, respectively [Baker, 2008a]). Although the maximum vanadium concentration detected in Upland Reference Area No. 3 subsurface soil exceeds the maximum background concentration for fine sand/silt subsurface soil (232 mg/kg [Baker, 2008a]), this concentration is less than the ULM background concentration established for this soil type (256 mg/kg [Baker, 2008a]). Given that the soil textural classification assigned to subsurface soil samples REF-SB09 and REF-SB10 is “clay” (REF-SB10; see Table 4-8) and all detected concentrations are less than ULM background

concentrations established for clay subsurface soils at NAPR, as well as ULM background concentrations established for fine sand/silt subsurface soils at NAPR, it can be concluded that detections of these two metals in Upland Reference Area No. 3 subsurface soil are not elevated above background concentrations.

Cobalt concentrations detected in Upland Reference Area No. 3 subsurface soil (28 mg/kg in REF-SB09 and 50 mg/kg in REF-SB10) exceed the maximum and/or ULM background concentration established for clay subsurface soils at NAPR (33.8 mg/kg and 26.9 mg/kg, respectively [Baker, 2008a]). Both detected concentrations are less than maximum and ULM background concentrations established for fine sand/silt subsurface soils (73.4 mg/kg and 63.1 mg/kg, respectively [Baker, 2008a]). Given that the soil textural classification for the REF-SB09 and REF-SB10 subsurface soil samples is “clay” (see Table 4-8) and the detected cobalt concentration in each sample exceed the ULM background concentration established for clay subsurface soils at NAPR, it can be concluded that cobalt concentrations in Upland Reference Area No. 3 subsurface soil are elevated above background levels.

Based on the comparison of surface and subsurface soil analytical data to soil screening values and background screening values (i.e., maximum and ULM background concentrations), Upland Reference Area Nos. 1 is deemed appropriate as a source of reference area soil for *Eisenia fetida* toxicity testing. Detected concentrations in surface and subsurface soil at this upland reference area were less than soil screening values and/or background screening values. Upland Reference Area Nos. 2 and 3 are not deemed appropriate as a source of reference soil for toxicity testing. Chromium and vanadium were detected in Upland Reference Area No. 2 subsurface soil at concentrations greater than soil and background screening values. Chromium and vanadium also were detected in Upland Reference Area No. 3 surface soil at concentrations greater than soil and background screening values. In addition, cobalt was detected in Upland Reference Area No. 3 subsurface soil at concentrations greater than soil and background screening values.

4.1.1.3 Selection of Upland Reference Area for BERA Field Investigation

Based on the evaluation of soil characteristics presented in Section 4.1.1.1, Upland Reference Area No. 2 was deemed most appropriate as a source of surface soil for *Eisenia fetida* toxicity testing, while Upland Reference Area No. 3 was deemed most appropriate as a source of subsurface soil. However, chromium and vanadium were detected in Upland reference Area No. 2 subsurface soil and chromium, vanadium, and cobalt were detected in Upland Reference Area No. 3 surface and/or subsurface soil at concentrations greater than soil and background screening values (see Sections 4.1.1.2.2 and 4.1.1.2.3, respectively). No chemical was detected above soil and background screening values in surface and subsurface soil collected at Upland Reference Area No. 1. However, soil collected at this upland reference area exhibited considerable differences in TOC content and/or grain size characteristics. Although chromium and vanadium were detected in Upland Reference Area No. 2 subsurface soil at concentrations greater than soil and background screening values, this upland reference area is considered most appropriate for the collection of soil for *Eisenia fetida* toxicity testing. This conclusion is largely based on the successful use of Upland Reference Area No. 2 as a source of surface soil for *Eisenia fetida* toxicity testing during a BERA conducted at SWMU 1 (Baker, 2009). Specifically, earthworms exposed to Upland Reference Area No. 2 surface soil met the minimum requirements specified by ASTM (2006a) for control soil (i.e., greater than 90 percent mean survival in each replicate test chamber at test termination). The uncertainty associated with the selection of Upland Reference Area No. 2 as a source of soil for the BERA at SWMU 2 is discussed in Section 7.0.

4.1.2 Estuarine Wetland Reference Area

Sediment was collected from the estuarine wetland adjacent to SWMU 2 and from a single estuarine wetland reference area during Step 5 of the ERA process (see Figure 3-3). Sampling activities were conducted from February 28, 2007 to March 1, 2007. Table 3-1 provided a summary of the sediment samples collected at SWMU 2 and the estuarine wetland reference area. As evidenced by Table 3-1, six sediment samples were collected at SWMU 2 (2V-EWSD01 through 2V-EWSD06) and six sediment samples were collected at the estuarine wetland reference area (REF-EWSD01 through REF-EWSD06). Each SWMU 2 and reference area sediment samples were analyzed for ammonia, sulfide, pH, and zinc. The reference area sediment samples also were analyzed for the ecological COCs identified in Step 3a of the ERA process for benthic invertebrate direct contact exposures and avian invertivore food web exposures (i.e., copper, lead, mercury, and zinc), as well as TOC. Analytical results for sediment collected at SWMU 2 are presented in Table 4-10, while analytical results for sediment collected at the estuarine wetland reference area are presented in Table 4-11. Analytical data for associated QA/QC field samples (i.e., equipment rinsate and field blanks) are presented in Table 4-9.

The proposed estuarine wetland reference area was evaluated based on physical, chemical, and biological properties. As outlined in Section 3.1.2, the reference area was deemed acceptable for use as a source of reference soil for *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity testing and as a source of fiddler crab tissue for the evaluation of avian invertivore dietary exposures if the following conditions were met:

- The habitat offered by the estuarine wetland reference area is similar to habitat found within the estuarine wetland portion of SWMU 2 (mangrove community).
- The ranges of ammonia, sulfide, and TOC concentrations, as well as the range of grain size characteristics in estuarine wetland reference area sediment are similar to the ranges found in SWMU 2 estuarine wetland sediment.
- Maximum copper, lead, mercury, and zinc concentrations in reference area sediment do not exceed the sediment screening values listed in Section 2.5.4 (copper: 18.7 [MacDonald, 1994]; lead: 30.2 mg/kg [MacDonald, 1994]; mercury (0.13 mg/kg [MacDonald, 1994], and zinc: 124 mg/kg [MacDonald, 1994]) or ULM background screening values established for estuarine wetland sediments within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (132 mg/kg for copper, 25.4 mg/kg for lead, 0.17 mg/kg for mercury, and 96.9 mg/kg for zinc [Baker, 2008a]).
- Maximum lead and mercury concentrations in estuarine wetland reference area sediment do not exceed ULM background sediment screening values for estuarine wetland sediments established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (25.4 mg/kg for lead and 0.17 mg/kg for mercury [Baker, 2008a]).

An evaluation of the reference area against these criteria is presented within the sections that follow.

4.1.2.1 Habitat

As discussed in Section 2.2.2 and Appendix A, the estuarine wetland at SWMU 2 includes red and black mangrove communities. Specific wetland units located within the estuarine wetland system

downgradient from SWMU 2 have the following Cowardin classifications: E2SS3 and E2US2 (see Section 2.2.2). As evidenced by Figure 2-5, E2SS3 wetland units represent the dominant community. The estuarine wetland reference area also includes black and red mangrove communities. Identical to SWMU 2, the E2SS3 wetland units represent the dominant community. E2US3 (Estuarine, Intertidal, Unconsolidated Shore, Mud) and E2US4 (Estuarine, Intertidal, Unconsolidated Shore, Organic) wetland units also are present at the estuarine wetland reference area (see Figure 3-3). Fiddler crabs were prevalent throughout the reference area during verification of the field sampling design. Based on the habitat criterion established within the Final Steps 3b and 4 Report (presence of habitat similar to that encountered at SWMU 2), as well as the presence of a large fiddler crab population, the estuarine wetland area is considered appropriate for the collection of fiddler crab tissue

4.1.2.2 Physical and Chemical Properties of Sediment

The physical properties of estuarine wetland sediment collected at SWMU 2 and the estuarine reference area during verification of the field sampling design are presented in Tables 4-10 and 4-11, respectively. Table 4-12 presents historical TOC and grain size analytical data for SWMU 2 estuarine wetland sediment samples collected during the 2003 additional data collection field investigation. A summary of the data presented in Tables 4-10 through 4-12 is provided in the table below.

Parameter	SWMU 2 Range	Reference Area Range
TOC (mg CaCO ₃ /kg)	26,000 – 93,000	19,000 – 120,000
Ammonia (mg/kg)	2 – 16	5.5 – 99.6J
Sulfide (mg/kg)	ND – 250	ND – 790J
Grain Size (percent)		
Gravel	0.0 – 6.4	0.0 – 3.1
Sand	9.2 – 55.6	0.7 – 30.0
Silt/Clay	43.8 – 91.9	70.1 – 99.3

TOC concentrations measured in the SWMU 2 and reference area sediment samples showed considerable variability. In general, TOC concentrations measured in the reference area sediment exceed TOC concentrations measured in the SWMU 2 sediment samples (with exception of REF-EWSD01 and REF-EWSD06, all reference area sediment samples had a TOC concentration greater than or equal to 84,000 mg/kg, while only two of ten (2/10) SWMU 2 sediment samples had TOC concentrations greater than 84,000 mg/kg). Grain size characteristics of reference area sediment and SWMU 2 sediment were similar. However, the SWMU 2 sediment samples collected during verification of the field sampling design trended toward a higher sand content and were less finely grained than the reference area and historical SWMU 2 sediment samples. With the exception of REF-EWSD04, total ammonia concentrations in estuarine wetland sediment were similar to concentrations measured in SWMU 2 estuarine wetland sediments. The total ammonia concentration detected in REF-EWSD04 (99.6J mg/kg) is considerably higher than the maximum concentration detected at SWMU 2 (16 mg/kg in 2V-EWSD04). All detected sulfide concentrations in reference area sediment (270J mg/kg in REF-EWSD02, 470J mg/kg in REF-EWSD04, and 790J mg/kg in REF-EWSD05) exceed the maximum SWMU 2 concentration (250J mg/kg in 2V-EWSD04).

Although the reference area sediment samples exhibited higher TOC, ammonia, and sulfide concentrations than sediment collected at SWMU 2, the range of measured concentrations at each location overlap. In addition, grain size characteristics at each location are similar (sediment samples at each location are dominated by finely grained sediments). For these reasons, the estuarine wetland

reference area is considered an appropriate source of sediment for *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity testing.

4.1.2.3 Comparison of Copper, Lead, Mercury, and Zinc Analytical Data to Sediment Screening Values

As outlined in Section 3.1.2, the estuarine wetland reference area was considered acceptable as a source of sediment for *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity testing if ecological COCs(copper, lead, mercury, and zinc) were not detected at concentrations greater than sediment screening values or the background estuarine wetland sediment screening values established in the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008a).

As evidenced by Table 4-11, lead, mercury, and zinc were detected in each reference area sediment sample collected during verification of the field sampling design. Maximum detected concentrations (lead: 9 mg/kg in REF-EWSD06, mercury: 0.07J mg/kg in REF-EWSD02, zinc: 71J mg/kg in REF-EWSD06) are less than sediment screening values (30.2 mg/kg for lead, 0.13 mg/kg for mercury, and 124 mg/kg for zinc). Copper also was detected in each reference area sediment sample. Detected concentrations, ranging from 36J mg/kg in REF-EWSD05 to 59J mg/kg in REF-EWSD01, exceed the sediment screening value (18.7 mg/kg). However, detected concentrations are less than maximum and ULM background concentrations established for estuarine wetland sediments at NAPR (132 mg/kg [Baker, 2008a], indicating that detections in estuarine wetland reference sediment are representative of background levels. The comparisons presented above indicate that the estuarine wetland reference area is considered an appropriate source of sediment for *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity testing.

4.1.2.4 Comparison of Lead and Mercury Analytical Data to Background Sediment Screening Values

The estuarine wetland reference area was considered acceptable as a source of fiddler crab tissue for the evaluation of avian invertivore food web exposures if lead and mercury were not detected at concentrations greater than the background estuarine wetland screening values established in the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008b). As discussed in Section 4.1.2.3, lead and mercury were detected in each reference area sediment sample. Lead was detected at concentrations ranging from 2.4 mg/kg in REF-EWSD01D to 9 mg/kg in REF-EWSD07, while mercury was detected at concentrations ranging from 0.044 mg/kg in REF-EWSD01 to 0.07J mg/kg in REF-EWSD02). Maximum detected concentration are less than maximum and ULM background concentrations established for estuarine wetland sediments at NAPR (maximum background concentrations: 38 mg/kg for lead and 0.21 mg/kg for mercury; ULM background concentrations: 25.4 mg/kg for lead and 0.17 mg/kg for mercury [Baker, 2008a], indicating that that detections in estuarine wetland reference sediments are representative of background levels. The comparisons presented above indicate that the estuarine wetland reference area is considered an appropriate source of fiddler crab tissue for the evaluation of avian invertivore food web exposures.

Based on the evaluation presented in Sections 4.1.2.1 through 4.1.2.4, the estuarine wetland reference area is an appropriate source of sediment for *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity testing and an appropriate source of fiddler crab tissue for the evaluation of avian invertivore food web exposures.

4.1.3 Open Water Reference Areas

Three open water reference areas (Open Water Reference Area No. 1, Open Water Reference Area No. 2, and Open Water Reference Area No. 3) were evaluated in Step 5 of the ERA process for SWMU 2 (Baker, 2008a). Open Water Reference Area No. 1 was established within Puerca Bay, Open Water Reference Area No. 2 was established within an Embayment of the Ensenada Honda, adjacent to the former Officer's Beach (approximately 1.0 mile from the open water portion of SWMU 2), while Open Water Reference Area No. 3 was established within Pelican Bay (Figure 3-1). Activities associated with the evaluation included the collection of six sediment samples at Reference Area No. 1 (REF1-SD01V through REF1-SD06V), six sediment samples at Reference Area No. 2 (REF2-SD01V through REF2-SD06V), and two sediment samples at Reference Area No. 3 (REF3-SD01V and REF3-SD02V). Sample locations are depicted on Figures 3-4 (Open Water Reference Area No. 1) and 3-5 (Open Water Reference Area Nos. 2 and 3). The open water reference areas were sampled on September 20 and September 21, 2006 during verification of the field sampling design for a BERA at SWMU 45. Each sediment sample was analyzed for the ecological COCs unique to SWMU 2 West Indian manatee dietary exposures (i.e., arsenic, cadmium, copper, lead, mercury, selenium, and zinc), as well as TOC and grain size. Analytical results for sediment collected from Open Water Reference Area Nos. 1, 2, and 3 are summarized in Tables 4-13, 4-14, and 4-15, respectively, while analytical results for associated equipment rinsate and field blanks are summarized in Table 4-16.

The proposed open water reference areas were evaluated based on biological, physical, and chemical properties. As outlined in Section 3.1, a given reference area was deemed acceptable for use as a source of turtle grass tissue for the BERA field investigation (Step 6) if the following conditions were met:

- The habitat offered by the reference area is similar to habitat found within the open water portion of SWMU 2 (climax turtle grass community).
- The range of TOC concentrations and grain size characteristics in open water reference area sediment are similar to the ranges found in sediment located within the open water portion of SWMU 2.
- Maximum arsenic, cadmium, copper, lead, mercury, selenium, and zinc concentrations in open water reference area sediment do not exceed the background open water sediment screening values established within the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* ([arsenic: 10.5 mg/kg; cadmium: 1.52 mg/kg; copper: 29 mg/kg; lead: 5.4 mg/kg; mercury: 0.056 mg/kg; selenium: 1.08 mg/kg; zinc: 32 mg/kg [Baker, 2008a]).

An evaluation of the open water reference areas against these criteria is presented within the sections that follow.

4.1.3.1 Habitat

As discussed in Section 2.2.2, seagrass meadows are prevalent throughout much of the Ensenada Honda, including the open water portion of SWMU 2. Seagrass meadows within the Ensenada Honda, including the area downgradient from SWMU 2, are dominated by a nearly continuous cover of turtle grass with a high abundance of calcareous green algae (*Halimeda incrassate*, *Halimeda opuntia*, *Penicillia* spp., *Avranvillia* spp., *Ventricaria ventricosa*, *Caulerpa* spp., *Valonia* spp., and *Udotea* spp.) (Reid et al., 2001). The dominance by turtle grass and the absence of opportunistic

seagrass species (i.e., shoal grass) indicates that the Ensenada Honda's seagrass meadows are in the climax stage and have not experienced any recent disturbances which were severe enough to alter the equilibrium species composition (Reid et al., 2001). Based on the modified Braun-Blanquet scale (Braun-Blanquet, 1972), Reid et al. (2001) report that turtle grass coverage within the Ensenada Honda ranges from 50 percent to greater than 75 percent (Reid et al., 2001), while macroalgae coverage ranges from 50 to 75 percent.

Turtle grass cover was not quantitatively measured at each open water reference area during verification of the field sampling design. However, observations indicate that turtle grass cover at Open Water Reference Area No. 1 ranges from approximately 50 percent to greater than 90 percent, while turtle grass cover at Open Water Reference Area No. 2 ranges from approximately 50 percent to greater than 65 percent. Identical to SWMU 2, the dominant seagrass species at both open water reference areas is turtle grass, indicating the presence of a climax community. Marine algae (unknown species) also are prevalent at both open water reference locations. Identical to turtle grass, macroalgae coverage was not quantitatively measured during verification of the field sampling design. However, observations indicate similar macroalgae coverage at Open Water Reference Areas Nos. 1 and 2 as that measured within the Ensenada Honda by Reid et al. (2001). Turtle grass and macroalgae cover at Open Water Reference Area No. 3 was sparse (less than 10 percent). Based on the habitat criterion established within the Final Steps 3b and 4 Report (i.e., presence of a climax turtle grass community [Baker, 2007] and similar turtle grass and macroalgae coverage, Open Water Reference Area Nos. 1 and 2 are both deemed appropriate for the collection of turtle grass tissue, while Open Water Reference Area No. 3 is deemed inappropriate.

4.1.3.2 Physical Properties of Sediment

TOC concentrations in nine SWMU 2 open water sediment samples collected during the 2003 additional data collection field investigations (see Table 4-17) ranged from 18,000 mg/kg (02OWSD08) to 55,000 mg/kg (02OWSD03). Of the nine measured concentrations, only two exceed 40,000 mg/kg (see Table 4-17). TOC concentrations measured in Open Water Reference Area No. 1 sediment samples range from 27,000 mg/kg (REF-SD02V) to 66,000 mg/kg (REF1-SD01V). Of the six samples collected, four have measured TOC concentrations ranging from 60,000 mg/kg to 66,000 mg/kg (see Table 4-13). These data indicate that TOC concentrations measured in Open Water Reference Area No. 1 sediment samples are generally higher than concentrations measured at SWMU 2. TOC concentrations measured in Open Water Reference Area No. 2 sediments (9,300 mg/kg in REF2-SD04V to 67,000 mg/kg in REF2-SD06V) were generally lower than concentrations measured at SWMU 2 and Open Water Reference Area No. 1 (see Table 4-14). With the exception of REF2-SD06V, all reported values were less than or equal to 20,000 mg/kg. As discussed in Section 3.1, only two sediment samples were collected at Reference Area No. 3 due the high shell content of the sediment relative to SWMU 2 and low seagrass coverage (less than 10 percent). TOC concentrations in these two sediment samples are most similar to Open Water Reference Area No. 2 sediments (5,100 mg/kg in REF3-SD01V and 24,000 mg/kg in REF3-SD02V).

The grain size distribution data presented in Tables 4-13 through 4-15 and Table 4-17 indicate that SWMU 2 sediments are more finely grained than sediments at each open water reference area (i.e., reference area sediment samples were comprised of somewhat coarser material (greater sand content and lower silt/clay content). Grain size distribution data for sediments collected at Open Water Reference Area No. 3 confirmed the visual observation made in the field. As evidenced by Table 4-15, sediments collected at this open water reference area exhibited high gravel content (34.7 percent in REF3-SD01V and 32.5 percent in REF3-SD02V) relative to SWMU 2 (0.0 percent in each sample)). The high percentage of gravel measured in each Reference Area No. 3 sediment sample is likely attributable to the presence of crushed shell pieces. Although each open water reference area

exhibited higher sand content and lower silt/clay content than SWMU 2, grain size distributions reported for Open Water Reference Area No. 1 are most similar to the distributions reported for SWMU 2

The analytical data presented in Tables 4-13 through 4-17 indicate that Open Water Reference Area No. 1 sediments are most similar to SWMU 2 sediments with regard to TOC content and grain size characteristics. Based on the analysis of physical and chemical properties, Open Water Reference Area No. 1 is deemed most appropriate as a source of turtle grass tissue for the evaluation of West Indian manatee dietary exposures.

4.1.3.3 Comparison of Analytical Data to Background Sediment Screening Values

As outlined in the Final Step 3b and 4 Report (Baker, 2007) and Section 3.1 herein, a given reference area was considered acceptable as a source of turtle grass tissue in Step 6 of the BERA if arsenic, cadmium, copper, lead, mercury, selenium, and zinc were not detected at concentrations greater than the open water background sediment screening values (i.e., ULM background concentrations) established in the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008a).

As Open Water Reference Area No. 3 was deemed unacceptable for use in Step 6 as a source of turtle grass tissue (based on the presence of sparse seagrass cover [see Section 4.1.3.1]), the arsenic, cadmium, copper, lead, mercury, selenium, and zinc analytical data for this reference area were not evaluated. A comparison of the Reference Area Nos. 1 and 2 sediment analytical data to background sediment screening values is provided below.

4.1.3.3.1 *Open Water Reference Area No. 1*

Arsenic, cadmium, copper, lead, mercury, selenium, and zinc were detected in each sediment sample (see Table 4-13). As evidenced by the table below, maximum detected arsenic, cadmium, mercury, and selenium concentrations are less than background sediment screening values (Baker, 2008a).

Chemical	Maximum Concentration (mg/kg)	Background Sediment Screening Value (mg/kg)
Arsenic	9J	10.5
Cadmium	0.093J	1.52
Copper	59	29
Lead	5.7	5.4
Mercury	0.047J	0.056
Selenium	0.47J	1.08
Zinc	38	32

Copper was detected in four sediment samples at concentrations greater than the ULM background concentration (35 mg/kg in REF1-SD02V and REF1-SD03V, 59 mg/kg in REF1-SD04, and 33J in REF1-SD05V). In addition, zinc was detected in three sediment samples and lead was detected in one sediment sample at concentrations greater than ULM background concentrations (zinc: 38 mg/kg in REF1-SD02V, 33 mg/kg in REF1-SD03V, and 36 mg/kg in REF1-SD04V; lead: 5.7 mg/kg in REF1-SD02V). Copper and zinc detections greater than ULM background concentrations also exceed maximum background concentrations for these two metals (29.1 mg/kg for copper and 32 mg/kg for zinc [Baker, 2008a]).

4.1.3.3.2 Open Water Reference Area No. 2

Arsenic, copper, and lead were detected in each sediment sample, selenium was detected in four of six (4/6) sediment samples, while mercury and zinc were each detected in a single sediment sample (see Table 4-14). Cadmium was not detected in any of the Open Water Reference Area No. 2 sediment samples. As evidenced by the table below, maximum detected concentrations and, in the case of cadmium, maximum reporting limits are less than background sediment screening values.

Chemical	Maximum Concentration (mg/kg)	Background Sediment Screening Value (mg/kg)
Arsenic	2.6J	10.5
Cadmium	0.22UJ	1.52
Copper	7.4J	29
Lead	2J	5.4
Mercury	0.011J	0.056
Selenium	0.3J	1.08
Zinc	9.4J	32

Based on the comparison of the analytical data to background sediment screening values, Open Reference Area No. 2 is deemed most appropriate as a source of turtle grass tissue for the evaluation of West Indian manatee dietary intakes.

4.1.3.4 Selection of Open Water Reference Area for the BERA Field Investigation

Based on the evaluation presented in Sections 4.1.3.1 through 4.1.3.3, Open Water Reference Area No. 2 is considered most appropriate for the collection of sea grass tissue. Open Water Reference Area No. 2 exhibits similar habitat characteristics (e.g. climax turtle grass community). Furthermore, sediment samples collected from Open Water Reference Area No. 2 did not contain ecological COCs at concentrations greater than background open water sediment screening values (i.e., ULM background concentrations). Although Open Water Reference Area No. 1 exhibits similar habitat characteristics as SWMU 2 and sediments from this location are most similar to SWMU 2 sediments with regard to TOC content and grain size characteristics, this reference area is not considered appropriate for used as a source of turtle grass tissue based on the presence of copper, lead, and zinc in one or more sediment samples at concentrations greater than ULM background concentrations (see Section 4.1.3.3). Open Water Reference Area No. 3 also is considered inappropriate as a source of turtle grass tissue based on low seagrass coverage at this location (i.e., less than 10 percent).

4.2 BERA Field Investigation

The sections that follow present and discuss the results of the soil, sediment (estuarine wetland and open water sediment), fiddler crab tissue, and turtle grass tissue samples collected during the BERA field investigation (conducted May 18, 2007 to May 20, 2007). The *Eisenia fetida* (earthworm), *Leptocheirus plumulosus* (amphipod), and *Neanthes arenaceodentata* (polychaete) toxicity test results and analytical data for tissue samples collected from earthworms maintained in soil during toxicity testing are also presented and discussed.

4.2.1 Quick-Turn Soil Samples

Fifty surface soil samples (designated 2B-SS01 through 2B-SS50) and ten subsurface soil samples (designated 2B-SB01-01, 2B-SB02-01, 2B-SB04-01, and 2B-SB06-01 through 2B-SB10-00) were collected from the upland habitat at SWMU 2 using the procedures presented in Section 3.2.1 (see Table 3-5 and Figure 3-6). An additional six surface soil samples (designated 2B-REF-SS01 through 2B-REF-SS06) and six subsurface soil samples (designated 2B-REF-SB01-01 through 2B-REF-SB06-01) were collected from Upland Reference Area No. 2 (see Table 3-5 and Figure 3-7). Each SWMU 2 and Upland Reference Area No. 2 soil sample was analyzed for antimony, copper, lead, mercury, and zinc (ecological COCs for terrestrial invertebrate direct contact exposures) on a quick-turn basis in accordance with the analytical methodology presented in Table 3-6. The validated quick-turn analytical results for the SWMU 2 surface and subsurface soil samples are presented in Tables 4-18 and 4-19, respectively, while the validated quick-turn analytical results for the Upland Reference Area No. 2 surface and subsurface soil samples are presented in Tables 4-20 and 4-21, respectively. The soil data tables include analytical results for the surface soil and subsurface soil field duplicates collected at SWMU 2 (2B-SB04D, 2B-SS14D, 2B0SS24D, 2B-SS34D, 2B-SS44D, and 2B-SB04-01D) and Upland Reference Area No. 2 (2B-REF-SS04D and 2B-REF-SB04-01D). Analytical results for associated equipment rinsate and field blanks are summarized in Table 4-22.

As evidenced by Tables 4-20, maximum detected antimony, lead, mercury, and zinc concentrations in Upland Reference Area No. 2 surface soil (0.74 mg/kg, 29J mg/kg, 0.044 mg/kg, and 49J mg/kg, respectively) are less than the soil screening values presented in Table 3-3 (78 g/kg, 1,700 mg/kg, 0.1 mg/kg, and 120 mg/kg, respectively). Maximum lead, mercury, and zinc concentrations in Upland Reference Area No. 2 subsurface soil (7.5 mg/kg, 0.059 mg/kg, and 49 mg/kg) also are less than soil screening values (see Table 4-21). Antimony was not detected in any of the subsurface soil samples collected at Upland Reference Area No. 2. The maximum non-detected result for this metal (0.25U mg/kg) is less than the soil screening value. Copper was detected in five of six surface soil samples and two of six subsurface soil samples collected at Upland Reference Area No. 2 at concentrations greater than the soil screening value established for this metal (70 mg/kg). However, maximum detected concentrations (100J mg/kg in surface soil and 95 mg/kg in subsurface soil) are less than the ULM background screening values established in the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (Baker, 2008a; 169 mg/kg for surface soil and 246 mg/kg for subsurface soil [clay]), indicating that copper detections in Upland Reference Area No. 2 are representative of background levels. These data support the selection of Upland Reference area No. 2 as a source of reference soil for the BERA field investigation.

Analytical results for the SWMU 2 surface and subsurface soil samples collected during the BERA field investigation presented in Tables 4-18 and 4-20 were combined with analytical results for surface and subsurface soil collected during the 1992 SI, 1996 RFI, and 2004 additional data collection field investigation (see Table 2-5 and 2-6) into unified data set. An analytical summary of the unified soil data set, including maximum, arithmetic mean, and 95 percent UCL of the mean concentrations, is presented in Table 4-23. As discussed above, duplicate samples were collected in the field. The analytical data summary presented in Table 4-23 addresses duplicates in the following manner:

- If a given ecological COC was detected in the original sample and its field duplicate, the maximum concentration was used as a conservative estimate of the ecological COC concentration at a particular sampling point.

- If a given ecological COC was detected in either the original sample or field duplicate and non-detected in the other, the detected concentration was used as a conservative estimate of the ecological COC concentration at a particular sampling point.
- If a given ecological COC was not detected in the original sample and field duplicate, the maximum non-detected value (i.e., maximum reporting limit) was used as a conservative estimate of the ecological COC concentration at a particular sampling point.

The unified data set summarized in Table 4-23 was used to derive risk estimates (i.e., HQ values) for terrestrial invertebrate direct contact exposures to ecological COCs in SWMU 2 soil. HQ values, derived using maximum, arithmetic mean, 95 percent UCL of the mean COC concentrations, and the soil screening values identified in Section 2.5.4 and presented in Table 3-3, are included within Table 4-23. 95 Percent UCL of the mean concentrations were calculated using USEPA ProUCL Version 4.00.04 software (USEPA, 2009a and 2009b; see Appendix G). A discussion of the SWMU 2 analytical data and risk estimates is presented in the sections below.

4.2.1.1 Antimony

Antimony was detected in eighty of ninety-four (80/94) soil samples at concentrations ranging from 0.036J mg/kg to 36 mg/kg (see Table 4-23). All detected concentrations are less than the soil screening value (78 mg/kg; USEPA, 2005a). Antimony detections in eight surface soil samples exceed the ULM background surface soil screening value (3.17 mg/kg; Baker, 2008a). A background subsurface soil screening value was not established for this metal due to the lack of detected concentrations in the clay subsurface soil background data set (Baker, 2008a). HQs values based on the maximum concentration (36 mg/kg), 95 percent UCL of the mean concentration (6.17 mg/kg), and arithmetic mean concentration (2.58 mg/kg) are 0.46, 0.08, and 0.03, respectively. The absence of detected antimony concentrations greater than the soil screening value is a line of evidence supporting a conclusion of minimal risk to soil invertebrate communities from antimony in SWMU 2 soil.

4.2.1.2 Copper

Copper was detected in ninety-three of ninety-four (93/94) soil samples at concentrations ranging from 16.9 mg/kg to 19,300J mg/kg (see Table 4-23). Seventy detections (fifty-three in surface soil and seventeen in subsurface soil) exceed the soil screening value of 80 mg/kg (USEPA, 2007a). Copper detections in twenty-six surface soil samples and six subsurface soil samples also exceed their respective ULM background soil screening value (168 mg/kg for background surface soil and 246 mg/kg for background subsurface soil [clay]; Baker, 2008a). HQ values for the unified soil data set using the maximum concentration (19,300 mg/kg), 95 percent UCL of the mean concentration (1,546 mg/kg), and arithmetic mean concentration (548 mg/kg) are 241.25, 19.33, and 6.85, respectively. The frequency of detected concentrations greater than the soil screening value and ULM background concentrations, the magnitude of the maximum detected concentration above the soil screening value (maximum HQ = 241.25), and HQ values greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean concentrations (HQs = 19.33 and 6.85, respectively) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from copper in SWMU 2 soil.

4.2.1.3 Lead

Lead was detected in each soil sample (94/94) at concentrations ranging from 3.1 mg/kg to 5,850J mg/kg (see Table 4-23). Two surface soil detections (4,760J mg/kg in 06SS14 [sample collected during the 1992 SI] and 3,550J mg/kg [sample collected during the BERA field investigation]) and

one subsurface soil detection (5,850J mg/kg [sample collected during the 1992 SI]) exceed the soil screening value (1,700 mg/kg; USEPA, 2005d). These detections also exceed their respective ULM background soil screening value (22 mg/kg for surface soil and 6.3 mg/kg for subsurface soil [clay]; Baker, 2008a). HQ values for the unified soil data set using the maximum concentration (5,850J mg/kg), 95 percent UCL of the mean concentration (503 mg/kg), and arithmetic mean concentration (355 mg/kg) are 3.44, 0.30, and 0.21, respectively. The frequency and magnitude of detected concentrations greater than the soil screening value is low and HQ values based on 95 percent UCL of the mean and arithmetic mean concentrations are less than 1.0 (0.30 and 0.21, respectively). These factors are lines of evidence supporting a conclusion of minimal risk to soil invertebrate communities from lead in SWMU 2 soil.

4.2.1.4 Mercury

Mercury was detected in eighty-eight of ninety-four (88/94) soil samples at concentrations ranging from 0.026 mg/kg to 19J mg/kg (see Table 4-23). Sixty-one detections (fifty in surface soil and eleven in subsurface soil) exceed the soil screening value (0.10 mg/kg; Efroymson et al., 1997b), as well as their respective ULM background soil screening value (0.109 mg/kg for background surface soil and 0.108 for background subsurface soil [clay]; Baker, 2008a). HQ values based on the maximum concentration (19J mg/kg), 95 percent UCL of the mean concentration (1.513 mg/kg), and arithmetic mean concentration (0.54 mg/kg) are 190.00, 15.13, and 5.41, respectively. The frequency of detected concentrations greater than the soil screening value and ULM background concentrations, the magnitude of the maximum detected concentration above the soil screening value (maximum HQ = 190.00), and HQ values greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean concentrations (HQs = 15.13 and 5.41, respectively) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from mercury in SWMU 2 soil.

4.2.1.5 Zinc

Zinc was detected in ninety-four of ninety-four (94/94) soil samples at concentrations ranging from 8.3 mg/kg to 12,700J mg/kg (see Table 4-23). Sixty-three detections (forty-eight in surface soil and fifteen in subsurface soil) exceed the soil screening value (120 mg/kg; USEPA, 2007c), as well as their respective ULM background soil screening value (115 mg/kg; Baker, 2008b), and the ULM background subsurface soil concentration (88 mg/kg; Baker, 2008b). HQ values based on the maximum concentration (12,700 mg/kg), 95 percent UCL of the mean concentration (1,566 mg/kg), and arithmetic mean concentration (602 mg/kg) are 105.83, 13.05, and 5.02, respectively. The frequency of detected concentrations greater than the soil screening value and ULM background concentrations, the magnitude of the maximum detected concentration above the soil screening value (maximum HQ = 105.83), and HQ values greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean concentrations (HQs = 13.05 and 5.02, respectively) are lines of evidence supporting a conclusion of unacceptable risk to soil invertebrate communities from zinc in SWMU 2 soil.

In summary, the comparison of maximum, 95 percent UCL of the mean, and arithmetic mean concentrations to invertebrate-based soil screening values support a conclusion of minimal risks from antimony and lead to terrestrial invertebrate communities. Antimony was not detected in any soil sample at a concentration greater than the invertebrate-based soil screening value. In the case of lead, the frequency and magnitude of detections above the soil screening value is low (three of ninety-four [3/94] soil samples; HQ value based on the maximum detected concentration is 3.44). In addition, HQ values for this metal based on 95 percent UCL of the mean and arithmetic mean concentrations are less than 1.0 (0.30 and 0.21, respectively). The evaluation performed on the copper, mercury, and zinc soil data support a conclusion of unacceptable risks from these three metals to terrestrial invertebrate communities. HQ values based on 95 percent UCL of the mean concentrations also

exceed 1.0 (HQ of 15.13 for mercury, and 13.05 for zinc). Furthermore, the frequency of detected copper, mercury, and zinc concentrations above soil screening values is high, ranging from sixty-one of ninety-four (61/94) soil samples for mercury to seventy of ninety-four (70/94) soil samples for copper.

It is noted that for metals, total concentrations in soil are poor predictors of toxicity due to a number of modifying factors, including pH, organic matter content, cation exchange capacity (CEC) and clay content (Ma, 1984, Beyer et al., 1987, Rhoads et al., 1989, Alva et al., 2000, Scott-Fordsmand et al., 2000, Maiz et al., 2000, Adriano, 2001, Lock and Janssen, 2001, Boyd and Williams, 2003, and Broos et al., 2007). For these reasons, the comparison of total soil concentrations to literature-based toxicological thresholds does not provide an accurate determination of bioavailability and toxicity.

4.2.2 Earthworm Toxicity Test Soil Samples

As discussed in Sections 3.2.1 and 4.2.1, fifty SWMU 2 surface soil samples, eight SWMU 2 subsurface soil, six Upland Reference Area No. 2 surface soil samples, and six Upland Reference Area No. 2 subsurface soil samples were submitted to the analytical laboratory (STL) for quick-turn analyses. Each SWMU 2 and reference area soil sample was analyzed for the ecological COCs identified in Step 3a of the ERA process for terrestrial invertebrates (i.e., antimony, copper, lead, mercury, and zinc; see Tables 4-18 through 4-21). Upon receipt of the unvalidated analytical results in the field, twelve SWMU 2 soil samples (2B-SS04, 2B-SB04-01, 2B-SS05, 2B-SS10, 2B-SS13, SB-SS14, SB-SS31, 2B-SS33, 2B-SS34, 2B-SS41, 2B-SS44, and 2B-SS49) and three Upland Reference Area No. 2 soil samples (2B-REF-SB01-01, 2B-REF-SS04, and 2B-REF-SS05) were submitted to the toxicity testing laboratory (Fort Environmental Laboratories, Inc.) for 28-day *Eisenia fetida* survival, growth, and reproduction tests. A portion of each soil sample submitted for toxicity testing also was analyzed for TOC, pH, and grain size using the methodology summarized in Table 3-6. Analyses were conducted by STL on a standard turn (i.e., 28 days).

The specific soil samples selected for earthworm toxicity testing exhibit a range of ecological COC concentrations, from non-detected values or values below soil screening values to maximum detected concentrations. To the extent possible, the co-location of ecological COCs was considered when soil samples were selected for toxicity testing. The Upland Reference Area No. 2 soil samples selected for toxicity testing (2B-REF-SB01-01, 2B-REF-SS04, and 2B-REF-SS05) exhibited similar physical characteristic as those observed in the SWMU 2 soil samples selected for toxicity testing (i.e., TOC content and grain size characteristics [apparent, based on field observations and professional judgment]). Because unvalidated, quick-turn analytical results were used to select the soil samples submitted for earthworm toxicity testing, potential QA/QC issues associated with these data were not taken into consideration during the selection process. However, a review of the validation narratives included as Appendix F did not reveal any substantial data quality issues (i.e., analytical data where not rejected during data validation activities).

The specific concentration gradients present within the SWMU 2 soil samples submitted for toxicity are summarized below. The results shown represent validated data.

- Antimony: 0.24U mg/kg (2B-SS49), 0.28J mg/kg (2B-SS10), 0.38J mg/kg (2B-SS13), 0.73J mg/kg (2B-SS34), 0.76J mg/kg (2B-SS14), 1J mg/kg (2B-SS33), 1.5J mg/kg (2B-SS05), 1.8J mg/kg (2B-SS04), 2.3J mg/kg (2B-SS31), 6.6 mg/kg (2B-SS41), 8.7 mg/kg (2B-SS44), and 36 mg/kg (2B-SB04-01).
- Copper: 41 mg/kg (2B-SS49), 74.1J mg/kg (2B-SS14), 135J mg/kg (2B-SS10), 137J mg/kg (2B-SS13), 170 mg/kg (2B-SS41), 200 mg/kg (2B-SS44), 219J mg/kg (2B-SS04), 357J

mg/kg (2B-SS33), 409J mg/kg (2B-SS05), 1,000J mg/kg (2B-SB04-01), 8,130J mg/kg (2B-SS34), and 19,300 mg/kg (2B-SS31).

- Lead: 8.1 mg/kg (2B-SS49), 113 mg/kg (2B-SS10), 260 mg/kg (2B-SS41), 279J mg/kg (2B-SS33), 290 mg/kg (2B-SS44), 305 mg/kg (2B-SS13), 314 mg/kg (2B-SS31), 637J mg/kg (2B-SS34), 746 mg/kg (2B-SS05), 795 mg/kg (2B-SS14), 1,400 mg/kg (2B-SB04-01), and 3,550J mg/kg (2B-SS04).
- Mercury: 0.048 mg/kg (2B-SS49), 0.099J mg/kg (2B-SS05), 0.13 mg/kg (2B-SS33), 0.17 mg/kg (2B-SS31), 0.2 mg/kg (2B-SS34), 0.31 mg/kg (2B-SS41), 0.35J mg/kg (2B-SS10), 0.43 mg/kg (2B-SS44), 0.48J mg/kg (2B-SS04), 0.94J mg/kg (2B-SB04-01), 4.2J mg/kg (2B-SS14), and 8.7J mg/kg (2B-SS13).
- Zinc: 32 mg/kg (2B-SS49), 124J mg/kg (2B-SS10), 179J mg/kg (2B-SS14), 196J mg/kg (2B-SS13), 345J mg/kg (2B-SS04), 441J mg/kg (2B-SS05), 760 mg/kg (2B-SS41), 1,100 mg/kg (2B-SS44), 2,710J mg/kg (2B-SS34), 3,800 mg/kg (2B-SB04-01), 5,080J mg/kg (2B-SS31), and 12,700J mg/kg (2B-SS33).

Toxicity tests were conducted in accordance with ASTM Standard E 1676-04: *Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm *Eisenia fetida* and the Enchytraeid Potworm *Enchytraeus albidus** (ASTM, 2006a). Test endpoints for *Eisenia fetida* were survival, calculated as the percentage of test organisms at test initiation that survived in each replicate at test termination; growth, calculated as weight loss per surviving earthworm in each replicate at test termination, and reproduction, expressed as the number of juveniles and cocoons per surviving earthworm in each replicate at test termination. The laboratory's toxicity report (included as Appendix E) summarizes the methodology used to conduct the *Eisenia fetida* toxicity tests. No protocol deviations from ASTM Standard E 1676-04 were recorded during the performance of the tests. It is noted that each SWMU 2 and reference area soil sample was tested using eight replicates, with 10 earthworms per replicate. ASTM Standard E 1676-04 recommends a minimum of three replicates per sample. Eight replicates were tested per sample in an attempt to increase the power of the toxicity tests by reducing the between-replicate (i.e., inter-replicate) variability of each endpoint.

Table 4-24 presents a summary of the toxicity test results and associated analytical data together. The sections that follow provide a discussion and analysis of the toxicity data.

4.2.2.1 Comparison of Biological Responses in SWMU 2 Soil to Biological Responses in Reference Area Soil

Eisenia fetida survival, growth, and reproduction data were statistically evaluated by the testing laboratory using SigmaStat® Version 2.03 statistical software (SPSS Inc., Chicago, IL). Statistical comparisons were made against the following test endpoints:

- Earthworm survival (percent) in each replicate at test termination
- Weight loss per surviving earthworm in each replicate at test termination
- Number of juveniles and cocoons per surviving earthworm in each replicate at test termination

The survival, growth (i.e. weight loss), and reproduction data were subjected to hypothesis testing to determine if measured biological responses in SWMU 2 and reference area soil samples are equal. Initially, normality and homogeneity of variance were tested at an alpha (α) of 0.05 using D'Agostino's test and Bartlett's test, respectively. D'Agostino's test was used instead of the Shapiro-Wilks test based on $N > 50$. Parametric one-way analysis of variance (ANOVA) tests were performed on those data sets that met the assumptions of normality and homogeneity of variance, while non-parametric Kruskal-Wallis one-way ANOVA tests were performed on those data sets that failed these assumptions. The ANOVAs tested the null hypothesis that the means (parametric data) or medians (non-parametric data) of each treatment, including reference soil, are equal (all data sets were tested on ranked data at a α of 0.05). When a statistically significant difference was detected for a given endpoint (i.e., differences in values among the treatments are greater than would be expected by chance), a multiple comparison procedure (Bonferroni t-test for parametric data and Dunn's method for non-parametric data) was run to isolate the specific treatments that differed. For a given endpoint, separate multiple comparison procedures were performed against each reference area soil sample. All statistical evaluations performed by the toxicity testing laboratory are included within Appendix E.

4.2.2.1.1 Evaluation of Toxicity Test Negative Control and Reference Soils

A negative control was run concurrently with the SWMU 2 and Upland Reference Area No. 2 soil samples to ensure that the population of test organisms used in the toxicity tests was healthy. The negative control was tested using an organic top soil and peat moss mixture. As the initial moisture content of the control soil was less than 25 percent, soil was hydrated prior to use in the toxicity tests. Dechlorinated tap water was used to hydrate the control soil to a target percent moisture content of 25 percent to 45 percent (Stafford and Edwards, 1985 as cited in ASTM, 2006a). Hydration water was prepared by passing tap water through a 5 micrometer (μm) pre-treatment filter to remove solids, a 3.6 cubic foot (cf) activated carbon filter to remove chlorine, ammonia, and higher molecular weight organics, and a 5 μm post-filter to remove any carbon particles from the carbon treatment phase. This same water was also used to hydrate, as necessary, the SWMU 2 and Reference Area No. 2 soil samples (see soil chemistry attachment in Appendix E). Minimum acceptable performance for the negative laboratory control is specified by ASTM Standard E 1676-04 as mean survival greater than or equal to 90 percent at test termination. Mean control survival was 98.75 percent with an inter-replicate survival range of 90 to 100 percent. Based on these data, it is concluded that the earthworm population used as a source of test organisms for toxicity testing was healthy and toxicity test results are valid.

As discussed in Section 4.2.2, three soil samples collected from Upland Reference Area No. 2 were tested concurrently with the SWMU 2 soil samples. These reference samples were tested to provide a site-specific basis for evaluating toxicity (survival, growth, and reproduction in SWMU 2 soil samples were statistically compared to survival, growth, and reproduction in each reference area soil sample). Good health of organisms used in each reference soil samples was demonstrated. Specifically, mean survival of test organisms exposed to reference soil samples 2B-REF-SB01-01, 2B-REF-SS04, and 2B-REF-SS05 was 100.00 percent (Table 4-24). As test organisms exposed to the reference samples met the minimum criteria for a healthy population, it was concluded that statistical comparisons of survival, growth, and reproduction between SWMU 2 soil samples and reference area soil samples are reliable.

4.2.2.1.2 *Survival*

The Kruskal Wallis one-way ANOVA on ranks (performed on arcsine square root transformed data) detected a significant difference in earthworm survival among treatment groups ($p < 0.001$). The follow-on multiple comparison procedures (Dunn's method) identified a significant decrease in median survival by earthworms exposed to SWMU 2 soil samples 2B-SS04-01 (0.00 percent) and 2B-SS34 (0.00 percent) relative to median survival by earthworms exposed to reference area soil samples 2B-REF-SB01-01, 2B-REF-SS04, and 2B-REF-SS05 (100 percent in each reference area soil sample) ($p < 0.05$; see Table 4-24 and Appendix E). As evidenced by the data presented in Table 4-24, a clear dose-response relationship between ecological COC concentrations and median earthworm survival was not established by the toxicity tests. Copper, lead, mercury, and zinc concentrations measured in 2B-SS04-01 and 2B-SS34 are less than concentrations measured in SWMU 2 soil samples that did not show a significant reduction in survival relative to 2B-REF-SB01-01, 2B-REF-SS04, and 2B-REF-SS05. Specifically, detected copper and zinc concentrations in 2B-SB04-01 (1,000J mg/kg and 3,800 mg/kg, respectively) and 2B-SS34 (8,130J mg/kg and 2,710J mg/kg, respectively) are less than detected concentrations in 2B-SS31 (19,300J mg/kg and 5,080J mg/kg). Detected lead concentrations in 2B-SB04-01 and 2B-SS41 (1,400 mg/kg and 360J mg/kg, respectively) are less than the detected concentration in 2B-SS04 (3,550J mg/kg). Finally, detected mercury concentrations in 2B-SB04-01 and 2B-SS41 (0.94J mg/kg and 0.31 mg/kg, respectively) are less than the detected concentration in 2B-SS13 and 2B-SS14 (8.7J mg/kg and 4.2J mg/kg, respectively). Although the maximum antimony concentration measured in SWMU 2 soil submitted for *Eisenia fetida* toxicity testing was measured in 2B-SB04-01 (36 mg/kg), this maximum concentration is less than the soil screening value of 78 mg/kg (Eco-SSL for terrestrial invertebrates [USEPA, 2005a]). The analytical data indicate that some physical and/or chemical parameter other than ecological COC concentrations may be responsible for or influencing the observed biological response (see Section 4.2.2.3). Regardless, the significant reduction in survival by earthworms exposed to SWMU 2 soil samples 2B-SS04-01 and 2B-SS34 is a line of evidence supporting unacceptable risk on this test endpoint.

4.2.2.1.3 *Growth*

The parametric one-way ANOVA on ranks detected a significant difference in earthworm weight loss among treatment groups ($p < 0.001$). The follow-on multiple comparison procedures (Bonferroni t-test) identified a significant increase in mean weight loss by earthworms exposed to SWMU 2 soil samples 2B-SS31 and 2B-SS49 (0.1773 grams and 0.1576 grams, respectively) relative to mean weight loss by earthworms exposed to reference area soil sample 2B-REF-SS05 (0.0993 grams) ($p < 0.05$; see Table 4-24 and Appendix E). A significant increase in mean weight loss by earthworms exposed to SWMU 2 soil sample 2B-SS31 (0.1773 grams) also was detected by the Bonferroni t-test relative to mean weight loss by earthworms exposed to reference area soil sample 2B-REF-SB01-01 (0.1238 grams) ($p < 0.05$). Identical to the survival endpoint, a clear dose-response relationship between ecological COC concentrations and mean weight loss cannot be established (see Table 4-24), indicating that some physical and/or chemical parameter other than ecological COC concentrations may be responsible for or influencing the observed biological response (see Section 4.2.2.3). Regardless, the significant increase in weight loss by earthworms exposed to SWMU 2 soil samples 2B-SS31 and 2B-SS49 is a line of evidence supporting unacceptable risk on this test endpoint.

SWMU 2 soil samples 2B-SB04-01 and 2B-SS34 were excluded from the statistical evaluation of growth data. Soil sample 2B-SB04-01 was excluded from evaluation because mortality in each replicate test chamber at test termination was 100 percent (no earthworms were available for dry weight measurements), while soil sample 2B-SS34 was excluded from evaluation because the sample

size was too small to be conducive to hypothesis testing (only one test organism survived until test termination).

4.2.2.1.4 *Reproduction*

The Kruskal Wallis one-way ANOVA on ranks detected a significant difference in earthworm reproduction (number of juveniles and cocoons per surviving earthworm) among treatment groups ($p < 0.001$). The follow-on multiple comparison procedures (Dunn's method) detected a significant difference in reproduction between SWMU 2 soil samples 2B-SS31, 2B-SS41, and 2B-SS44 and each reference area soil sample ($p < 0.05$; see Table 4-24 and Appendix E). However, the statistical difference detected by Dunn's method represents a significant increase in reproduction by earthworms exposed to these three SWMU soil samples relative to reproduction by earthworms exposed to reference area soil samples (median number of juveniles and cocoons per surviving earthworm in 2B-SS31, 2B-SS41, and 2B-SS44 was 0.789, 0.550, and 0.450, respectively, while no juveniles or cocoons per surviving earthworm were recorded for the reference area soil samples). For the reasons discussed in Section 4.2.2.1.3, SWMU 2 soil samples 2B-SB04-01 and 2B-SS34 were excluded from the statistical evaluation of reproduction data.

Although the statistical evaluations did not detect a significant difference in reproduction in any of the SWMU 2 soil samples relative to reproduction in the reference area soil samples, no reproduction occurred in six SWMU 2 soil samples statistically evaluated (2B-SS04, 2B-SS05, 2B-SS10, 2B-SS14, 2B-SS33, and 2B-SS49). However, as noted above, reproduction also was not evident in each of the reference area soil samples. Therefore, it cannot be concluded that the lack of reproduction in 2B-SS04, 2B-SS05, 2B-SS10, 2B-SS14, 2B-SS33, and 2B-SS49 represents an adverse site-related effect by one or more of the ecological COCs.

4.2.2.3 Evidence of a Significant Correlation between Laboratory Toxicity Test Results and the Chemical/Physical Characteristics of Soil

When a toxicological response to a particular chemical occurs, there is typically a sigmoidal relationship between the response and the amount of chemical to which the receptor is exposed (i.e., the dose). In such a relationship, there is nearly always a dose below which no response occurs or can be measured. Furthermore, there is a dose above which no additional response will be observed. At doses intermediate to these two levels, the relationship between dose and response resembles a linear function. As discussed in Section 4.2.2.1.2, the statistical comparisons performed by the testing laboratory indicated that earthworm survival in SWMU 2 soil samples 2B-SS04-01 and 2B-SS34 were significantly lower than earthworm survival in reference area soil samples 2B-REF-SB01-01, 2B-REF-SS04, and 2B-REF-SS05. Statistical evaluations performed by the testing laboratory also indicated that earthworm weight loss in SWMU 2 soil samples 2B-SS31 and 2B-SS49 was significantly greater than earthworm weight loss in reference soil sample 2B-REF-SS05 and/or 2B-REF-SB01-01 (see Section 4.2.2.1.3).

NCSS statistical and power analysis software [<http://www.ncss.com>] was used to run pair-wise linear regressions that examined the relationship between earthworm survival and weight loss and the chemical/physical characteristics of the soils. The regression analysis included each soil sample submitted for toxicity testing (twelve SWMU 2 and three Upland Reference Area No. 2 soil samples). The following soil variables were included in the analysis: antimony, copper, lead, mercury, and zinc (ecological COCs for terrestrial invertebrate direct contact exposures; non-detected results were evaluated as detected at the reporting limit), TOC (results reported by the analytical laboratory), test soil pH (day 0 and day 28 measurements performed by the toxicity testing laboratory), and grain size

(percent gravel, sand, and fines [silt and clay]). Prior to running the pair-wise linear regressions, survival data were transformed using arcsine square root transformation.

NCSS output pages for each regression are included within Appendix H. Results of the linear regressions are summarized in Table 4-25. For a given variable, the results presented in Table 4-25 are expressed as the correlation coefficient (r) and coefficient of determination (r^2). The correlation coefficient is an index that ranges from one to negative one. When a value is near zero, there is no linear relationship. As the correlation gets closer to plus or minus one, the relationship is stronger. A value of one (or negative one) indicates a perfect linear relationship between variables. The coefficient of determination is an index that ranges from zero to one. A value near zero indicates no linear relationship, while a value near one indicates a perfect linear fit. As evidenced by Appendix H and Table 4-25, the linear regression analysis indicated that copper, lead, mercury and zinc did not have a significant influence on earthworm survival or weight loss per surviving earthworm. The following soil variables also had no influence on earthworm survival or weight loss: TOC, pH at test initiation, pH at test termination, percent gravel, percent sand, and percent fines. Antimony had a significant influence on earthworm survival. The regression report for this variable shows that earthworm survival decreased as antimony concentrations increased. There was no significant influence by antimony on earthworm weight loss.

The linear regression reports presented in Appendix H include scatter plots for each soil variable and test endpoint combination. The scatter plot showing earthworm survival versus antimony illustrates that the negative relationship is driven by percent survival in the SWMU 2 soil sample containing the maximum antimony concentration (0 percent survival in soil sample 2B-SB04-01 containing antimony at 36 mg/kg). A simple linear regression between earthworm survival and antimony after exclusion of sample 2B-SB04-01 does not indicate that a significant relationship exists ($r = 0.1196$ and $r^2 = 0.0143$; significance level at $\alpha = 0.05$ is 0.6838). In addition, the only other soil sample with survival rates significantly less than those in reference area soils (1.25 percent in 2B-SS34) had a detected antimony concentration of only 0.73 mg/kg. These data do not exemplify a dose-response relationship between earthworm survival and antimony concentrations, and indicate that other factors, such as additive, synergistic, or antagonistic effects of co-located ecological COCs and soil properties and/or unmeasured soil traits, may be influencing earthworm survival.

As noted in Section 4.2.1, physical properties of soils, including TOC, pH, and grain size characteristics, have been shown to affect the bioavailability of metals in soil. To further evaluate the potential relationship between TOC, pH, grain size, ecological COC concentrations in soil, and earthworm responses in the toxicity tests (i.e., survival and weight loss), a multiple regression analysis was performed using NCSS software. Initially, the All Possible Regressions variable selection routine was run with the following independent variables: antimony, copper, lead, mercury, zinc, TOC, soil pH at test initiation and test termination, percent gravel, percent sand, and percent fines. The variable selection routine was run to (1) identify every independent variable that is even remotely related to the dependent variable (survival or growth), and (2) eliminate those independent variables that are irrelevant since their inclusion would decrease the precision of the multiple regression analysis.

NCSS printouts showing the results of the variable selection routine are included as Appendix H. Based on the eleven independent variables selected (i.e., antimony, copper, lead, mercury, zinc, TOC, soil pH at test initiation and test termination, percent gravel, percent sand, and percent fines), 2,048 separate models were run for each dependent variable (i.e., earthworm survival and weight loss). For a given dependent variable, plots showing the number of independent variables in each model versus r^2 values were examined to determine the point at which the increase in the r^2 value with the addition of an independent variable levels off (i.e., a plateau in the curve is achieved). The r^2 versus variable

count plot for survival indicates that beyond the inclusion of five variables in the model, r^2 values do not increase substantially. The model with five independent variables with the highest r^2 value (0.7717) includes antimony, soil pH at test initiation, percent gravel, percent sand, and percent fines. The r^2 versus variable count plot for growth also indicates that beyond the inclusion of five independent variables in the model, the r^2 values do not increase substantially. The model with five independent variables with the highest r^2 value (0.7456) includes copper, mercury, lead, TOC, and percent gravel.

Based on the independent variables identified by examination of the variable selection routine, multiple regressions were run to determine if the models selected for analysis had a significant influence on earthworm survival and growth. NCSS printouts showing the results of the multiple regressions, included within Appendix H, show that the five independent variable model for survival was significant ($p = 0.0099$). Within the model, antimony, percent gravel, percent sand, and percent fines had a significant influence on earthworm survival ($p = 0.0136$ for antimony and $p = 0.0052$ for each of the three grain size parameters). The five independent variable model for growth also was significant ($p = 0.0269$). Within the model, copper and percent gravel had a significant influence of earthworm weight loss ($p = 0.0030$ and 0.0305 , respectively).

In summary, the lack of a dose-response relationship in the data paired with the significant multiple regression results suggest that the bioavailability and toxicity of ecological COCs are being influenced by physical characteristics of the soil (i.e., grain size characteristics). However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured soil trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in soil and earthworm responses in the toxicity tests. Therefore, the toxicity test results could not be used to establish site-specific NOAELs for terrestrial invertebrate direct contact exposures to ecological COCs in SWMU 2 soil.

4.2.3 Earthworm Tissue

Tissue data from earthworms maintained in soil during toxicity testing were used to evaluate potential risks to terrestrial avian omnivores that may forage within the upland habitat at SWMU 2. The Final Steps 3a and 4 Report (Baker, 2007) specified that one composite tissue sample would be prepared for each soil sample tested for toxicity by combining all surviving earthworms from each replicate at test termination. Although twelve SWMU 2 soil samples were submitted to the toxicity testing laboratory for 28-day *Eisenia fetida* survival, growth, and reproduction tests, only eleven earthworm tissue samples prepared and submitted to the analytical laboratory. A tissue sample was not prepared for soil sample 2B-SB04-01 because all earthworms died prior to test termination (see Section 4.2.2.1.2 and Table 4-24). The earthworm tissue samples were prepared by transferring surviving earthworms to vessels containing damp filter paper for a period of 24 hours. After depuration, earthworms were transferred to sample containers, frozen, and shipped on dry ice to the analytical laboratory (STL-Savannah). Each earthworm tissue sample was analyzed for antimony, copper, lead, mercury, zinc, and percent lipids (see Table 3-5) using the analytical methodology summarized in Table 3-6. The SWMU 2 and Upland Reference Area No. 2 earthworm tissue analytical data are presented in Tables 4-26 and 4-27 respectively. Analytical results for each sample are reported as wet-weight and dry-weight concentrations. The analytical laboratory did not report the percent solids content of the earthworm tissue samples. Therefore, the dry-weight concentrations presented in Tables 4-26 and 4-27 were estimated by dividing wet-weight concentrations by the approximate solids content of earthworms (16 percent [0.16]; USEPA, 1993).

4.2.3.1 Comparison of American Robin Dietary Intakes at SWMU 2 to Ingestion-Based Toxicity Reference Values

American robin dietary intakes at SWMU 2 were estimated using the following formula modified from USEPA (1993):

$$DI_x = \frac{[[\sum_i [(FIR)(FC_{xi})(PDF_i)]] + [(FIR)(SC_x)(PDS)]] [AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg-BW/day)
FIR	=	Mean food ingestion rate (kg/day, dry-weight)
FC_{xi}	=	95 percent UCL of the mean concentration of chemical x in food item i (mg/kg, dry weight)
PDF_i	=	Proportion of diet composed of food item i (unitless; dry weight basis)
SC_x	=	95 percent UCL of the mean concentration of chemical x in surface soil (mg/kg, dry weight)
PDS	=	Proportion of diet composed of surface soil (unitless; dry weight basis)
BW	=	Mean body weight (kg, wet weight)
AUF	=	Area Use Factor (unitless)

The American robin was used as a representative species for terrestrial avian omnivores at SWMU 2. As outlined in Section 2.5.4, exposure parameters used for the American robin included a mean food ingestion rate of 0.00383 kg/day-dry weight (Levey and Karasov, 1989) and a mean body weight of 0.0773 kg (USEPA, 1993). Although the American robin is omnivorous, the exposure diet was assumed to be 90.9 percent earthworms and 9.1 percent surface soil (no plant material). It also was assumed that the American robin spends 100 percent of its time within the upland portions of SWMU 2.

Tissue concentrations used in the dietary intake equation were 95 percent UCL of the mean concentrations (dry weight basis) calculated using USEPA ProUCL Version 4.0.04 software (USEPA, 2009a and 2009b; see Appendix I). For a given ecological COC, when more than one 95 percent UCL of the mean concentration was calculated and recommended by USEPA ProUCL Version 4.0.04 software, the maximum value was conservatively selected for the estimation of dietary intakes. Soil concentrations used in the dietary intake equation also were 95 percent UCL of the mean concentrations derived for the data set summarized in Table 4-23 (combined data set for soil [surface and subsurface soil] collected during the 1992 SI, 1996 RFI, 2004 additional data collection investigation, and BERA field investigation; see Appendix G). Chemical-specific 95 percent UCL of the mean soil and earthworm tissue concentrations for antimony, copper, lead, mercury, and zinc are summarized below.

95 Percent UCL of the mean SWMU 2 soil concentrations

- 6.17 mg/kg antimony, 1,546 mg/kg for copper, 503 mg/kg for lead, 1.513 mg/kg for mercury, and 1,566 mg/kg for zinc

95 Percent UCL of the mean SWMU 2 earthworm tissue concentrations (dry weight basis)

- 0.81 mg/kg for antimony, 48.0 mg/kg for copper, 25.5 mg/kg for lead, 1.062 mg/kg for mercury, and 222 mg/kg for zinc

Ingestion-based risk estimates (i.e., HQ values) for the American robin were calculated by dividing dietary intakes by the literature-based NOAEL values summarized in Table 2-14. Sample et al. (1996) consider a scaling factor of 1.0 most appropriate for interspecies extrapolation between birds. Therefore, the NOAEL values summarized in Table 2-13 were not adjusted to reflect differences in body weights between avian test species and avian receptor species. As discussed in Section 2.4.1, it was conservatively assumed that all mercury at SWMU 2 is present as MeHg. Therefore, 95 percent UCL of the mean HQ values were derived using the NOAEL value from the study using methylmercury dicyandiamide as the test material (see Table 2-14).

Risk estimates for American robin dietary exposures to antimony, copper, lead, mercury, and zinc in SWMU 2 soil are summarized in Table 4-28. Although MATC- and LOAEL-based HQ values were not considered when determining acceptability of risk, these values also are presented in Table 4-28 (see explanation in Section 2.5.4). As evidenced by the table, copper, lead, and mercury NOAEL-based HQ values using 95 percent UCL of the mean soil and earthworm tissue concentrations are greater than 1.0 (2.74, 2.10, and 2.10, respectively). MATC-based HQ values for each metal also exceed 1.0 (1.58 for copper, 1.48 for lead, and 1.21 for mercury). The NOAEL-based HQ values, as well as the MATC-based HQ values, indicate that these three ecological COCs are bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations that feed exclusively on terrestrial invertebrates within the upland areas at SWMU 2. NOAEL-based risk estimates for American robin dietary exposures to antimony and zinc are less than 1.0 (<0.01 and 0.26, respectively). The NOAEL-based HQ values indicate that these two metals are not bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations feeding exclusively on terrestrial invertebrates at SWMU 2.

4.2.3.2 Comparison of American Robin Dietary Intakes at Upland Reference Area No. 2 to Ingestion-Based Toxicity Reference Values

To determine if potential risks presented by copper, lead, and mercury to terrestrial avian omnivore populations at SWMU 2 are site-related, risk estimates also were derived for American robin dietary exposures to these three metals in Upland Reference Area No. 2 soil. Based on the low number of soil samples collected at the upland reference area during the BERA field investigation (six soil samples) and the low number of upland reference area earthworm tissue samples submitted for analytical testing (three earthworm tissue samples), 95 percent UCL of mean soil and earthworm tissue concentrations could not be calculated. Therefore, upland reference area risk estimates were derived using maximum soil and earthworm tissue concentrations presented in Tables 4-20 and 4-21 (surface and subsurface soils, respectively) and 4-27 (earthworm tissue [dry weight basis]). Maximum reference area soil and earthworm tissue concentrations for copper, lead, and mercury are summarized below.

- Maximum Upland Reference Area No. 2 soil concentrations: 100J mg/kg for copper, 29J mg/kg for lead, and 0.059 mg/kg for mercury
- Maximum Upland Reference Area No. 2 earthworm tissue concentrations (dry weight basis): 25 mg/kg for copper, 4.8 mg/kg for lead, and 0.13 mg/kg for mercury

Maximum HQ values for American robin dietary exposures at Reference Area No. 2 are summarized in Table 4-29. As evidenced by the table, NOAEL-, MATC-, and LOAEL-based HQ values for each metal are less than 1.0. The maximum HQ values presented in Table 4-29 for Upland Reference Area No. 2 and the 95 percent UCL of mean HQ values summarized in Tables 4-28 for SWMU 2 clearly show that potential risks presented by copper, lead, and mercury in SWMU 2 soil are site-related.

4.2.4 Quick-Turn Estuarine Wetland Sediment Samples

Twenty-three SWMU 2 and six estuarine wetland sediment samples were submitted to the analytical laboratory for quick-turn analyses (see Section 3.2.4). Each SWMU 2 and reference area sediment sample was analyzed for the ecological COCs identified in Step 3a of the ERA process for aquatic invertebrates and estuarine wetland avian invertivores (copper, lead, mercury, and zinc) on a quick-turn basis in accordance with the analytical methodology presented in Table 3-6. Analytical results for the SWMU 2 and estuarine wetland reference area sediment samples are summarized in Table 4-30 and 4-31, respectively. The sediment data tables include analytical results for field duplicates collected at SWMU 2 (2B-EWSD04D and 2-EWSD14D) and the estuarine wetland reference area (2B-REF-EWSD04D). Analytical results for associated equipment rinsate and field blanks are summarized in Table 4-22.

As evidenced by Table 4-31, copper, lead, mercury, and zinc were detected in each estuarine wetland reference area sediment samples. As discussed in Sections 2.3 and 3.2.4, copper, lead, and zinc represent the ecological COCs for aquatic invertebrate direct contact exposures, while lead and mercury represent the ecological COCs for aquatic avian invertivore food web exposures. Maximum detected lead and zinc concentrations (8.3J mg/kg in and 70J mg/kg, respectively, in 2B-REF-EWSD04) are less than sediment screening values (30.2 mg/kg for lead and 124 mg/kg for zinc [MacDonald, 1994]). The maximum detected lead concentration, as well as the maximum detected mercury concentration (0.066J mg/kg) also are less than background screening values (ULM concentrations) established for these two metals established in the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (25.4 mg/kg for lead and 0.17 mg/kg for mercury [Baker, 2008a]). The maximum detected copper concentration in reference area sediment (140J mg/kg in 2B-REF-EWSD03) exceeds the sediment screening value (18.7 mg/kg [MacDonald, 1994]). This maximum concentration also exceeds the ULM background screening value established in the *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds* (132.44 mg/kg [Baker, 2008a]). However, the maximum reference area sediment concentration is equal to the maximum copper concentration reported within the background sediment data set. These data, in conjunction with the analytical data generated during verification of the field sampling design (see Table 4-11), support the selection of the estuarine wetland reference area as a source of sediment for the 28-day *Leptocheirus plumulosus* survival, growth and reproduction tests and the 20-day *Neanthes arenaceodentata* survival and growth tests, as well as a source of fiddler crab tissue for the evaluation of aquatic avian invertivore food web exposures.

A line of evidence selected for the evaluation of aquatic invertebrates at SWMU 2 involves a comparison of copper, lead, and zinc analytical data to sediment screening values (see section 2.5.4). For this evaluation, the quick-turn analytical results for the SWMU 2 estuarine wetland sediment samples presented in Table 4-30 were combined with the analytical results for SWMU 2 estuarine wetland sediment collected during the 2003 and 2004 additional data collection field investigations (see Table 2-9) into a unified data set. An analytical summary of the unified sediment data set, including maximum, arithmetic mean, and 95 percent UCL of the mean concentrations, is presented in Table 4-32. As discussed above, duplicate samples were collected in the field. The analytical data summary presented in Table 4-32 addresses duplicates using procedures listed in Section 4.2.1.

The unified data were used to derive risk estimates (i.e., HQ values) for benthic invertebrate exposures to ecological COCs in SWMU 2 estuarine wetland sediment. HQ values, derived using maximum, arithmetic mean, 95 percent UCL of the mean COC concentrations, and the sediment screening values identified in Section 2.4.1 (18.7 mg/kg for copper, 30.2 mg/kg for lead, and 124 mg/kg for zinc), are included within Table 4-32. 95 Percent UCL of the mean concentrations were calculated using USEPA ProUCL Version 4.00.04 software (USEPA, 2009a and 2009b; see Appendix J). A discussion of the SWMU 2 analytical data and risk estimates is presented below. Although mercury was not identified as an ecological COC for benthic invertebrate direct contact exposures (see Section 2.3), this metal was included in the evaluation based on the frequency of detected concentrations in the quick-turn sediment samples (six of twenty-three samples [6/23]) greater than the sediment screening value used in Step 2 of the SERA and Step3a of the BERA (0.13 mg/kg [MacDonald, 1994]).

4.2.4.1 Copper

Copper was detected in each of the wetland sediment samples [42/42] at concentrations ranging from 10J mg/kg to 710J mg/kg. Thirty-six detections exceed the sediment screening value of 18.7 mg/kg (MacDonald, 1994). Ten of these detections also exceed the ULM background sediment screening value (132.44 mg/kg; Baker, 2008a). HQ values based on the maximum concentration (710J mg/kg), 95 percent UCL of the mean concentration (140 mg/kg), and arithmetic mean concentration (108 mg/kg) are 37.97, 7.49 and 5.79, respectively. The frequency of detected concentrations greater than the sediment screening value and ULM background concentration, the magnitude of the maximum detected concentration above the sediment screening value (maximum HQ = 37.97), and HQ values greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean concentrations (7.49 and 5.79, respectively) are lines of evidence supporting a conclusion of unacceptable risk to benthic invertebrate communities from copper in SWMU 2 estuarine wetland sediment.

4.2.4.2 Lead

Lead was detected in forty of forty (40/40) sediment samples at concentrations ranging from 1.2J mg/kg to 450J mg/kg. Twelve detections exceed the sediment screening value (30.2 mg/kg; MacDonald, 1994). Fifteen detections also exceed the ULM background sediment screening value (25.40 mg/kg; Baker, 2008a). HQ values based on the maximum concentration (450J mg/kg), 95 percent UCL of the mean concentration (96.8 mg/kg), and arithmetic mean concentration (51.3 mg/kg) are 14.90, 3.21, and 1.70, respectively. The frequency of detected concentrations greater than the sediment screening value and ULM background concentration, the magnitude of the maximum detected concentration above the sediment screening value (maximum HQ = 14.90), and HQ values greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean lead concentrations (3.21 and 1.70, respectively) are lines of evidence supporting a conclusion of unacceptable risk to benthic invertebrate communities from lead in SWMU 2 estuarine wetland sediment.

4.2.4.3 Mercury

Mercury was detected in forty of forty (40/40) sediment samples at concentrations ranging from 0.015J mg/kg to 1.3 mg/kg. Fourteen detections exceed the sediment screening value (0.13 mg/kg; MacDonald, 1994). Thirteen detections also exceed the ULM background sediment screening value (0.17 mg/kg; Baker, 2008a). HQ values based on the maximum concentration (1.3 mg/kg), 95 percent UCL of the mean concentration (0.26 mg/kg), and arithmetic mean concentration (0.17 mg/kg) are 10.00, 2.02, and 1.32, respectively. The frequency of detected concentrations greater than the sediment screening value and ULM background concentration, the magnitude of the maximum detected concentration above the sediment screening value (maximum HQ = 10.00), and HQ values

greater than 1.0 based on 95 percent UCL of the mean and arithmetic mean lead concentrations (2.02 and 1.32, respectively) are lines of evidence supporting a conclusion of unacceptable risk to benthic invertebrate communities from mercury in SWMU 2 estuarine wetland sediment.

4.2.4.4 Zinc

Zinc was detected in thirty-two of thirty-two (32/32) sediment samples at concentrations at concentrations ranging from 10J mg/kg to 420 mg/kg. Five detections exceed the sediment screening value (124 mg/kg; MacDonald, 1994) and ULM background sediment screening value (96.9 mg/kg; Baker, 2008a). HQ values based on the maximum concentration (420 mg/kg), 95 percent UCL of the mean concentration (111 mg/kg), and arithmetic mean concentration (81.3 mg/kg) are 3.39, 0.89, and 0.66, respectively. The magnitude of the maximum detected concentration above the sediment screening value is low (maximum HQ = 3.39) and HQ values based on 95 percent UCL of the mean and arithmetic mean lead concentrations are less than 1.0 (0.89 and 0.66, respectively). These factors are lines of evidence supporting a conclusion of minimal risk to benthic invertebrate communities from zinc in SWMU 2 estuarine wetland sediment.

In summary, the comparison of maximum, 95 percent UCL of the mean, and arithmetic mean concentrations to invertebrate-based sediment screening values support a conclusion of minimal risks from zinc to benthic invertebrate communities. The zinc HQ value based on 95 percent UCL of the mean concentration is less than 1.0 (HQ = 0.89). In addition, the magnitude of the maximum detection above the sediment screening value is low (maximum HQ = 3.39). The evaluation performed on the copper, mercury, and lead sediment data support a conclusion of unacceptable risks from these metals to benthic invertebrate communities. HQ values based on 95 percent UCL of the mean concentrations exceed 1.0 (HQ of 7.49 for copper, 3.21 for lead, and 2.02 for mercury). Furthermore, the frequency of detected copper, mercury, and lead concentrations above sediment screening values is high (thirty-six of forty-two [36/42] sediment samples for copper, fourteen of forty [14/40] sediment samples for mercury, and twelve of forty [12/40] sediment samples for lead).

Identical to soil, total metals concentrations in sediment are poor predictors of toxicity due to a number of modifying factors, including pH, organic matter content, grain size characteristics, and AVS (Ankley et al., 1996, John and Leventhal, 1985, Luoma, 1983, NFESC, 2000, Pereira et al., 2008, Warren et al., 1994, and Wood and Shelley, 1999). For these reasons, the comparison of total sediment concentrations to literature-based toxicological thresholds does not provide an accurate determination of bioavailability and toxicity.

4.2.5 Acid Volatile Sulfide and Simultaneously Extracted Metals Analytical Data

As discussed in the proceeding section, total sediment concentrations are usually not predictive of the bioavailability and toxicity of metals. However, similar to nonionic organic chemicals, metal concentrations in sediment pore water have been correlated with toxicity (Adams et al., 1985, Swartz et al., 1985, and Kemp and Swartz, 1988). An important partitioning phase controlling the bioavailability and toxicity of cadmium, copper, lead, nickel, silver, and zinc is AVS (Ankley et al, 1996 and Berry et al., 1999). AVS represents a reactive pool of solid-phase sulfide that is available to bind these metals, rendering them biologically unavailable and nontoxic to sediment-associated biota. Cadmium, copper, lead, nickel, silver, and zinc, collectively termed SEM, represent those metals that form a more stable complex with sulfide than does iron. The model states that if the SEM concentration is less than the concentration of AVS, toxicity will not be observed. That is, if the SEM-to-AVS ratio is less than 1.0 or the SEM-to-AVS difference is less than zero (i.e., negative value), sufficient AVS is available to bind all the SEM and sediment-associated biota will not be exposed to toxic concentrations of these metals in the sediment pore water.

Ten SWMU 2 estuarine wetland sediment samples (2EWSD10 through 2EWSD19) collected during the 2004 Additional Data Collection Report (Baker 2006a) were analyzed for AVS and SEM. Sample locations are depicted on Figure 2-10. In addition, eight quick-turn SWMU 2 estuarine wetland sediment samples collected during the BERA field investigation were analyzed for AVS and SEM (2B-EWSD04, 2B-EWSD09, 2B-EWSD12, 2B-EWSD15, 2B-EWSD16, 2B-EWSD18, 2B-EWSD20, and 2B-EWSD24). Sample locations for these eight sediment samples are depicted on Figure 3-9. The quick-turn sediment samples analyzed for AVS and SEM also were tested for toxicity using the amphipod *Leptocheirus plumulosus* and the polychaete *Neanthes arenaceodentata* (see Section 4.2.6). The AVS and SEM analytical data for estuarine wetland sediment samples collected during the 2004 additional data collection field investigation and the BERA field investigation are summarized in Tables 4-33 and 4-35, respectively. Data are presented as molar concentrations (micromole per gram [$\mu\text{mole/gram}$]). The data tables include total SEM molar concentrations for each sample. It is noted that sediment samples collected during the 2004 additional data collection field investigation were not analyzed for the SEM metal silver.

Total SEM molar concentrations for sediment collected during the 2004 additional data collection field investigation were derived by summing individual SEM metal concentrations. In the case of sediment collected during the BERA field investigation, the following formula was used to derive total SEM molar concentrations:

$$[SEM]_{Total} = [SEM]_{Cd} + [SEM]_{Cu} + [SEM]_{Pb} + [SEM]_{Ni} + [SEM]_{Zn} + (0.5)[SEM]_{Ag}$$

One-half the molar concentrations of silver was added into the SEM totals because this metal is largely in a monovalent state. For both data sets, if an individual SEM metal was not detected in a sediment sample, the total SEM molar concentration for that sample was derived using the non-detected result (i.e., reporting limit). A summary of the AVS and SEM analytical data from each investigation is presented in Table 4-35. Included in the table are total SEM molar concentrations, AVS molar concentrations, and SEM-to-AVS ratios. Identical to the non-detected SEM results used in the derivation of total SEM molar concentrations, when AVS was not detected in a sediment sample, the SEM-to-AVS ratio for that sample was derived using the non-detected AVS result (i.e., reporting limit).

The AVS and SEM analytical data for sediment collected during the 2004 additional data collection field investigation were previously presented and discussed in the *Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2* (Baker, 2006a). As evidenced by Table 4-35, the molar concentration of AVS exceeds the molar concentration of SEM in nine of ten sediment samples (i.e., SEM-to-AVS ratios were less than 1.0). Therefore, it can be concluded that benthic invertebrates are not exposed to toxic concentrations of cadmium, copper, lead, nickel, and zinc in sediment pore water at locations where these nine samples were collected. The SEM-to-AVS ratio in sediment sample 2EWSD12 exceeds 1.0 (SEM-to-AVS ratio of 126). The high SEM-to-AVS ratio at this sample location can be attributed to the lack of detectable AVS. An examination of the analytical data for the individual SEM metals (see Table 4-33) show that copper, lead, and zinc are responsible for the SEM-to-AVS ratio derived for the 2EWSD12 sediment sample. The molar concentration of each metal (2.0458 $\mu\text{mole/gram}$ for copper, 0.6757 $\mu\text{mole/gram}$ for lead, and 3.5174 $\mu\text{mole/gram}$ for zinc) exceeds the non-detected AVS concentration (0.1248 $\mu\text{mole/gram}$). Total copper and lead concentrations detected in the 2EWSD12 sediment sample (280J mg/kg and 170 mg/kg, respectively [see Table 2-11]) exceed sediment screening values (18.7 mg/kg and 30.2 mg/kg, respectively [MacDonald et al., 1994]). Therefore, it can be concluded that benthic invertebrates may be exposed to toxic concentrations of these two metals in sediment pore water at the 2EWSD12 sampling location.

SEM-to-AVS ratios in four sediment samples collected during the BERA field investigation exceed 1.0 (161.4 in 2B-EWSD09, 4.5 in 2B-EWSD15, 54.9 in 2B-EWSD16, and 45.6 in 2B-EWSD24; see Table 4-35). As evidenced by Table 4-34, AVS was not detected in three of these samples (0.0561U $\mu\text{mole/gram}$ in 2B-EWSD09, 0.0468U $\mu\text{mole/gram}$ in 2B-EWSD16, and 0.0530U $\mu\text{mole/gram}$ in 2B-EWSD24), while the AVS molar concentration in the fourth sample was low (1.2477 $\mu\text{mole/gram}$ 2B-EWSD15). An examination of the analytical data presented in Table 4-34 shows that copper, lead, and/or zinc molar concentrations in 2B-EWSD09, 2B-EWSD15, 2B-EWSD16, and 2B-EWSD24 exceed AVS molar concentrations. Copper, lead, and zinc molar concentrations greater than the AVS molar concentration in each sample are listed below.

- 2B-EWSD09: AVS (0.0561U $\mu\text{mole/gram}$); copper (3.7768 $\mu\text{mole/gram}$); lead (2.3166J $\mu\text{mole/gram}$); zinc (2.9056J $\mu\text{mole/gram}$)
- 2B-EWSD15: AVS (1.2477 $\mu\text{mole/gram}$); copper (2.2031J $\mu\text{mole/gram}$); zinc (2.7527J $\mu\text{mole/gram}$)
- 2B-EWSD16: AVS (0.0468U $\mu\text{mole/gram}$); copper (1.5737 $\mu\text{mole/gram}$); lead (0.4247J $\mu\text{mole/gram}$); zinc (0.5505J $\mu\text{mole/gram}$)
- 2B-EWSD24: AVS (0.0530U $\mu\text{mole/gram}$); copper (1.3219 $\mu\text{mole/gram}$); lead (0.2654J $\mu\text{mole/gram}$); and zinc (0.8105J $\mu\text{mole/gram}$)

Total copper, lead and zinc concentrations detected in these four sediment samples also exceed the sediment screening values identified in Section 2.5.4. Detected total copper, lead, and zinc concentrations in 2B-EWSD09, 2B-EWSD15, 2B-EWSD16, and 2B-EWSD24 greater than sediment screening values are listed below.

- 2B-EWSD09: Copper (340J mg/kg); lead (440 mg/kg); zinc (420 mg/kg)
- 2B-EWSD15: Copper (220J mg/kg); lead (120 mg/kg), and zinc (240 mg/kg)
- 2B-EWSD16: Copper (170J mg/kg); lead (200 mg/kg); (zinc (270 mg/kg)
- 2B-EWSD24: Copper (200J mg/kg); lead (90 mg/kg); zinc (200 mg/kg)

The AVS and SEM data and total metals data indicate that benthic invertebrates may be exposed to toxic concentrations of copper, lead, and zinc in sediment pore water at the 2B-EWSD09, 2B-EWSD15, 2B-EWSD16, and 2B-EWSD24 sampling locations. It is noted that Ankley et al. (1996) state that, “*Chemical equilibrium calculations suggest that the relative affinity of metals to AVS should be copper > lead > cadmium > zinc > nickel*” (it is unclear how silver fits into this hierarchy). Hence, the appearance of metals in pore water as AVS is exhausted should occur in an inverse order (e.g., zinc would replace nickel in a monosulfide complex and nickel would be liberated to the pore water, etc.). This trend was, in fact, observed by Berry et al. (1996). Therefore, temporal fluctuations in estuarine wetland sediment AVS concentrations will not necessarily equate to the liberation of copper, lead, or zinc to sediment pore water at toxic concentrations for those sample locations currently indicated to have sufficient AVS to bind these ecological COCs.

As previously discussed, the quick-turn sediment samples analyzed for AVS and SEM were tested for toxicity using the amphipod *Leptocheirus plumulosus* and the polychaete *Neanthes arenaceodentata* (see Section 4.2.6 below). The analysis of the toxicity test data presented within this section includes

a statistical evaluation to determine if toxicity test results can be correlated with the chemical and physical characteristics of the sediment, including SEM-to-AVS ratios.

4.2.6 Amphipod and Polychaete Toxicity Test Sediment Samples

As discussed in Sections 3.2.4 and 4.2.4, twenty-three SWMU 2 and six estuarine wetland reference area sediment samples were submitted to the analytical laboratory for quick-turn analyses. Each SWMU 2 and reference area sediment sample was analyzed for the ecological COCs identified in Step 3a of the ERA process for benthic invertebrates and semi-aquatic avian invertivores (i.e., copper, lead, mercury, and zinc; see Tables 4-30 and 4-31). Upon receipt of the unvalidated analytical results in the field, eight SWMU 2 sediment samples (2B-EWSD04, 2B-EWSD09, 2B-EWSD12, 2B-EWSD15, 2B-EWSD16, 2B-EWSD18, 2B-EWSD20, and 2B-EWSD24) and two estuarine wetland reference area sediment samples (2B-REF-EWSD01 and 2B-REF-EWSD02) were submitted to the toxicity testing laboratory (Fort Environmental Laboratories, Inc.) for 28-day *Leptocheirus plumulosus* survival, growth, and reproduction tests and 20-day *Neanthes arenaceodentata* survival and growth tests. A portion of each sample submitted for toxicity testing was analyzed for TOC, ammonia, sulfide, grain size, pH, AVS, and SEM using the methodology summarized in Table 3-6. Analyses were conducted by STL on a standard turn (i.e., 28 days).

The specific sediment samples selected for amphipod and polychaete toxicity testing exhibited a range of copper, lead, and zinc concentrations, from non-detected values or values below sediment screening values to maximum detected concentrations. As discussed in Section 4.2.4, copper, lead, and zinc represent those chemicals identified as ecological COCs for benthic invertebrate direct contact exposures. To the extent possible, the co-location of ecological COCs was considered when sediment samples were selected for toxicity testing. The estuarine wetland reference area sediment samples selected for toxicity testing (2B-REF-EWSD01 and 2B-REF-EWSD02) exhibited similar physical characteristic as those observed in the SWMU 2 sediment samples selected for toxicity testing (i.e., TOC content and grain size characteristics [apparent, based on field observations and professional judgment]). Although mercury concentrations were not taken into consideration when selecting SWMU 2 sediment samples for toxicity testing (see Section 3.2.4), mercury concentrations detected in samples submitted for toxicity testing also span the range of concentrations measured in the quick-turn samples, including concentrations below the sediment screening value and the maximum concentration (0.81 mg/kg in 2B-EWSD16).

Because unvalidated, quick-turn analytical results were used to select the sediment samples submitted for amphipod toxicity testing, QA/QC issues associated with these data could not be taken into consideration during the selection process. However, identical to the quick-turn analytical data used to select soil samples for *Eisenia fetida* toxicity testing, a review of the validation narratives included as Appendix F did not reveal any substantial data quality issues associated with the quick-turn estuarine wetland sediment analytical data (i.e., analytical data where not rejected during data validation activities).

The specific copper, lead, mercury, and zinc concentration gradients tested for toxicity are summarized below. The results shown represent validated data.

- **Copper:** 21J mg/kg (2B_EWSD04), 67J mg/kg (2B-EWSD12), 130J mg/kg (2B-EWSD20), 170J mg/kg (2B-EWSD16), 200J mg/kg (2B-EWSD24), 220J mg/kg (2B-EWSD15), 340J mg/kg (2B-EWSD09), and 710J mg/kg (2B-EWSD18)

- Lead: 3.4J mg/kg (2B-EWSD04), 13J mg/kg (2B-EWSD12), 37J mg/kg (2B-EWSD20), 90 mg/kg (2B-EWSD24), 120 mg/kg (2B-EWSD15), 200 mg/kg (2B-EWSD16), 440 mg/kg (2B-EWSD09), and 450J mg/kg (2B-EWSD18)
- Mercury (COC for upper trophic level receptors only): 0.03J mg/kg (2B-EWSD04), 0.083J mg/kg (2B-EWSD12), 0.1 mg/kg (2B-EWSD24), 0.18J mg/kg (2B-EWSD20), 0.27J mg/kg (2B-EWSD18), 0.46 mg/kg (2B-EWSD09), 0.47 mg/kg (2B-EWSD15), and 0.81 mg/kg (2B-EWSD16)
- Zinc: 18J mg/kg (2B-EWSD04), 44J mg/kg (2B-EWSD12), 88J mg/kg (2B-EWSD20), 200J mg/kg (2B-EWSD18), 210 mg/kg (2B-EWSD24), 240 mg/kg (2B-EWSD15), 270 mg/kg (2B-EWSD16) and 420 mg/kg (2B-EWSD09)

The sections that follow provide a discussion and analysis of the *Leptocheirus plumulosus* and *Neanthes arenaceodentata* toxicity test data.

4.2.6.1 Amphipod Toxicity Tests

The 28-day *Leptocheirus plumulosus* survival growth and reproduction tests were conducted in accordance with EPA 600/R01-020 *Methods for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-Associated Contaminants with the Amphipod Leptocheirus plumulosus* (USEPA, 2001a). Test endpoints for *Leptocheirus plumulosus* were survival, calculated as the percentage of neonates at test initiation that survive as adults at test termination; growth, calculated as dry weight per surviving adult amphipod at test termination, and reproduction, calculated as juvenile production per surviving adult amphipod at test termination. As outlined in the Final Step 3b and 4 Report (Baker, 2006c), test endpoints for *Leptocheirus plumulosus* were survival, calculated as the percentage of test organisms at test initiation that survived as adults at test termination; growth, calculated as dry weight per surviving adult amphipod at test termination, and reproduction, calculated as juvenile production per surviving adult amphipod at test termination. The laboratory's toxicity report (included as Appendix E) summarizes the methodology used to conduct the *Leptocheirus plumulosus* toxicity tests. No protocol deviations from EPA 600/R-01-020 were recorded during the performance of the tests. It is noted that each SWMU 2 and reference area sediment sample was tested using eight replicates, with 20 amphipods per replicate. USEPA (2001a) methodology recommends a minimum of five replicates per sample. A total of eight replicates were tested per sample in an attempt to increase the power of the toxicity tests by reducing the between-replicate (i.e., inter-replicate) variability of each endpoint.

Table 4-36 presents a summary of the toxicity test results and associated analytical data. Included in the table are results of the various overlying water and pore water measurements performed by the toxicity testing laboratory. Total ammonia, pH, salinity, and sulfide measurements were conducted on pore water extracted from each SWMU 2 and reference area sediment sample prior to test initiation and again from a single replicate of each treatment at test termination. Dissolved oxygen, pH, salinity, sulfide, temperature, and total ammonia measurements were conducted on overlying water. Temperature and dissolved oxygen were measured on a daily basis throughout the tests, pH and salinity were measured at test initiation and on days 4, 6, 8, 11, 13, 15, 18, 20, 22, 25, and 28 of the toxicity tests (i.e., three times per week), while sulfide and total ammonia were measured at test initiation and on days 4, 6, 8, 13, 20, 28. The frequency of sulfide and total ammonia measurements were reduced to once per week once consistency between analytical results was determined. The overlying water analytical results included in Table 4-36 are limited to pH, salinity, total ammonia, and sulfide results for Day 0 (i.e., test initiation) and Day 28 (test termination). Results for the daily temperature and dissolved oxygen measurements, as well as results for the pH, salinity, sulfide, and

total ammonia measurements conducted on days 4, 6, 8, 11, 13, 15, 18, 20, 22, and 25 are included within the testing laboratory's toxicity report (see Appendix E). The sections that follow provide a discussion and analysis of the *Leptocheirus plumulosus* toxicity data.

4.2.6.1.1 Comparison of Biological Responses in SWMU 2 Estuarine Wetland Sediment to Biological Responses in Estuarine Wetland Reference Area Sediment

Leptocheirus plumulosus survival, growth, and reproduction data were analyzed by the testing laboratory using SigmaStat® Version 2.03 statistical software (SPSS Inc., Chicago, IL). Statistical comparisons were made against the following test endpoints:

- Amphipod survival (percent) in each replicate at test termination
- Dry weight per surviving amphipod in each replicate at test termination
- Number of juveniles per surviving amphipod in each replicate at test termination

The survival, growth (i.e. weight loss), and reproduction data were subjected to hypothesis testing to determine if measured biological responses in SWMU 2 and reference area sediment samples are equal. Initially, normality and homogeneity of variance were tested at an α of 0.05 using D'Agostino's test and Bartlett's test, respectively. D'Agostino's test was used instead of the Shapiro-Wilks test based on $N > 50$. Parametric one-way analysis of variance (ANOVA) tests were performed on those data sets that met the assumptions of normality and homogeneity of variance, while non-parametric Kruskal-Wallis one-way ANOVA tests were performed on those data sets that failed these assumptions. The ANOVAs tested the null hypothesis that the means (parametric data) or medians (non-parametric data) of each treatment, including reference sediments, are equal (all data sets were tested at α of 0.05). When a statistically significant difference was detected for a given endpoint (i.e., differences in values among the treatments are greater than would be expected by chance), a multiple comparison procedure (Bonferroni t-test for parametric data or Dunn's method for non-parametric data) was run to isolate the specific treatments that differed. For a given endpoint, separate multiple comparison procedures were performed against each reference area sediment sample. All statistical evaluations performed by the toxicity testing laboratory are included within Appendix E.

Evaluation of Toxicity Test Negative Control and Reference Sediments

A negative control was run concurrently with the SWMU 2 and estuarine wetland reference area sediment samples to ensure that the population of test organisms used in the toxicity tests was healthy. Sediment used for the negative control was laboratory reference sediment. Overlying water for the negative control, as well as the SWMU 2 and estuarine wetland reference area sediment samples tested for toxicity was reconstituted seawater prepared by adding Instant Ocean® to dechlorinated tap water (tap water was dechlorinated using the procedures presented in Section 4.2.2.1.1). Minimum acceptable performance for the laboratory control is specified as 80 percent survival on day 28 (with no individual replicate with less than 60 percent survival) and organisms must show evidence of growth and reproduction (USEPA, 2001a). Mean control survival was 96.87 percent with an inter-replicate survival range of 90 to 100 percent. Control organisms also showed evidence of growth (mean dry weight of 60 randomly selected amphipods at the start of the test was 0.0367 mg/organism, while mean dry weight of surviving amphipods at test termination was 0.1019 mg/organisms [see Appendix E]) and reproduction (mean juvenile production was 0.594 juveniles per

surviving amphipod). Based on these data, it is concluded that the amphipod population used as test organisms for toxicity testing was healthy and toxicity test results are valid.

Two sediment samples were collected from the estuarine wetland reference area and tested concurrently with the SWMU 2 sediment samples (2B-REF-EWSD01 and 2B-REF-EWSD02). These samples were collected to provide a site-specific basis for evaluating toxicity (survival, growth, and reproduction in SWMU 2 sediment samples were statistically compared to survival, growth, and reproduction in each reference area sediment sample). Good health of organisms used in each reference sediment samples was demonstrated. Mean survival of test organisms exposed to 2B-REF-EWSD01 and 2B-REF-EWSD02 was 93.75 percent. Furthermore, the inter-replicate survival range for 2B-REF-EWSD01 was 85 to 100 percent and for 2B-REF-EWSD02 was 75 to 100 percent. As discussed above, minimum acceptable performance is specified as 80 percent survival on day 28, with no individual replicate with less than 60 percent survival. Test organisms exposed to both reference samples also showed evidence of growth. Mean dry weight of surviving amphipods exposed to 2B-REF-EWSD01 and 2B-REF-EWSD02 were 0.1047 mg/organism and 0.1280 mg/organism, respectively, at test termination. This compares to a mean dry weight of 0.0367 mg/organism for 60 randomly selected amphipods at test initiation (see Appendix E). Finally, test organisms exposed to both reference samples showed evidence of reproduction. Juvenile production by test organisms exposed to 2B-REF-EWSD01 averaged 0.658 juveniles per surviving amphipod, while juvenile production by test organisms exposed to 2B-REF-EWSD02 averaged 0.925 juveniles per surviving amphipod. In addition to meeting the minimum acceptable criteria for survival, growth, and reproduction, each reference sediment sample did not contain ecological COCs at concentrations greater than sediment screening values (in the case of lead, mercury, and zinc) or ecological COCs at concentrations greater than ULM background screening values (in the case of copper). As test organisms exposed to the estuarine wetland reference sediment samples met the minimum criteria for a healthy population and both reference samples did not contain ecological COCs at concentrations greater than sediment screening values and ULM background concentrations, it was concluded that statistical comparisons of survival, growth, and reproduction between SWMU 2 sediment samples and reference area sediment samples are reliable.

Survival

The Kruskal Wallis one-way ANOVA on ranks detected a significant difference in amphipod survival (arcsine square root transformed data) among treatment groups ($p < 0.001$). The follow-on multiple comparison procedure (Dunn's method) identified a significant decrease in median survival by amphipods in six of the eight SWMU 2 sediment samples tested for toxicity (0.00 percent in 2B-EWSD09, 2.5 percent in 2B-EWSD12, 0.00 percent in 2B-EWSD15, 0.00 percent in 2B-EWSD18, 7.5 percent in 2B-EWSD20, and 0.00 percent in 2B-EWSD24) relative to median survival in the reference sediments (95.00 percent in 2B-REF-EWSD01 and 97.50 percent in 2B-REF-EWSD02) (see Table 4-36 and Appendix E). Median survival in 2B-EWSD04 (20.00 percent) and 2B-EWSD16 (10.00 percent), while not significantly lower than median survival in the reference sediments when statistically tested at a α of 0.05, also was reduced relative to median survival in both reference sediments. Low survival by amphipods exposed to each SWMU 2 sediment sample, including sediment samples with ecological COC concentrations less than sediment screening values and ULM background sediment screening values (2B-EWSD04 and 2B-EWSD12) indicate that some physical and/or chemical parameter other than the ecological COCs may be responsible for or influencing the observed biological response (see Section 4.2.6.1.2). Regardless, the significant reduction in survival by amphipods exposed to SWMU 2 sediment samples 2B-EWSD09, 2B-EWSD12, 2B-EWSD15, 2B-EWSD18, 2B-EWSD20, and 2B-EWSD24 is a line of evidence supporting unacceptable risk on this test endpoint.

Growth

The statistical evaluation of the amphipod growth data was impaired by low survival in SWMU 2 sediment samples 2B-EWSD09, 2B-EWSD12, 2B-EWSD15, 2B-EWSD18, and 2B-EWSD24. There were not surviving amphipods in 2B-EWSD18 and 2B-EWSD24 at test termination, while the number of surviving amphipods in 2B-EWSD09, 2B-EWSD12, and 2B-EWSD15 was too small to be conducive to hypothesis testing. Therefore, the statistical evaluation of growth data was limited to three SWMU 2 sediment samples (2B-EWSD04, 2B-EWSD16, and 2B-EWSD20). The parametric one-way ANOVA on ranks detected a significant difference in amphipod growth among treatment groups. The follow-on multiple comparison procedures (Bonferroni t-test) identified a significant decrease in mean dry weight per surviving amphipods exposed to each of the SWMU 2 sediment sample statistically evaluated (0.0536 grams in 2B-EWSD04, 0.0708 grams in 2B-EWSD16, and 0.0417 in 2B-EWSD20) relative to mean dry weight per surviving amphipods exposed to each reference sediment samples (0.1047 grams in 2B-REF-EWSD-01 and 0.1280 grams in 2B-EWSD-02). Identical to the survival endpoint, a clear dose-response relationship between ecological COC concentrations and mean dry weight per surviving amphipod cannot be established (see Table 4-36), indicating that some physical and/or chemical parameter other than ecological COC concentrations may be responsible for or influencing the observed biological response (see Section 4.2.6.1.2). Regardless, the significant decrease in growth by amphipods exposed to SWMU 2 sediment samples 2B-EWSD04, 2B-EWSD16, and 2B-EWSD20 is a line of evidence supporting unacceptable risk on this test endpoint.

Reproduction

The Kruskal Wallis one-way ANOVA on ranks detected a significant difference in amphipod reproduction among treatment groups ($p = 0.011$). However, the follow-on multiple comparison procedures (Dunn's method) did not identify any significant differences in reproduction in SWMU 2 samples relative to reference area samples (see Appendix E and Table 4-36). Identical to the statistical evaluations performed on the growth data, the statistical evaluation of the reproduction data was impaired by low survival. As was previously discussed, there were no surviving amphipods at test termination in 2B-EWSD18 and 2B-EWSD24. As such, these two sediment samples were excluded from the statistical evaluation of the reproduction data.

Although the statistical evaluations did not detected any significant differences in reproduction in SWMU 2 sediment samples relative to reproduction in reference area sediment samples, no reproduction occurred in three of six (3/6) SWMU 2 sediment samples statistically evaluated by the testing laboratory (2B-EWSD09, 2B-EWSD12, and 2B-EWSD15). The lack of reproduction in these three SWMU 2 sediment samples can be attributed to low survival (2B-EWSD09 had only one surviving amphipod at test termination, while 2B-EWSD12 and 2B-EWSD15 only had four surviving amphipods at test termination).

4.2.6.1.2 Evidence of a Significant Correlation between Laboratory Toxicity Test Results and the Chemical/Physical Characteristics of Sediment

As discussed in Section 4.2.2.3, when a toxicological response to a particular chemical occurs, there is typically a sigmoidal relationship between the response and the amount of chemical to which the receptor is exposed (i.e., the dose). In such a relationship, there is nearly always a dose below which no response occurs or can be measured. Furthermore, there is a dose above which no additional response will be observed. At doses intermediate to these two levels, the relationship between dose and response resembles a linear function. The statistical comparisons performed by the testing laboratory indicated that amphipod survival in SWMU 2 sediment samples 2B-EWSD09, 2B-

EWSD12, 2B-EWSD15, 2B-EWSD18, 2B-EWSD-20, and 2B-EWSD was significantly lower than amphipod survival in reference area sediment samples 2B-REF-EWSD01 and 2B-REF-EWSD02. Statistical evaluations performed by the testing laboratory also indicated that amphipod growth in SWMU 2 sediment samples 2B-EWSD04, 2B-EWSD16, and 2B-EWSD20 was significantly lower than amphipod growth in reference area sediment samples 2B-REF-EWSD01 and 2B-REF-EWSD02 (see Section 4.2.6.1.1).

NCSS statistical and power analysis software [<http://www.ncss.com>] was used to run pair-wise linear regressions that examined the relationship between amphipod survival and growth and the chemical/physical characteristics of the sediments. The regression analysis included each sediment sample submitted for toxicity testing (eight SWMU 2 and three estuarine wetland referenced area sediment samples). The following sediment variables were included in the analysis: copper, lead, and zinc (ecological COCs identified in Step 3a of the ERA process for benthic invertebrate direct contact exposures [Baker, 2006a]), mercury, SEM-to-AVS ratios, total ammonia, sulfide, pH, TOC, and grain size characteristics (percent gravel, percent sand, and percent fines [silt and clay]). In addition to the sediment variables identified above, the linear regression analysis included the following overlying water and pore water parameters: pH, salinity, and total ammonia. In the case of overlying water, these parameters were measured from one randomly selected replicate within each treatment on multiple days during the performance of the toxicity tests (see Section 4.2.6.1). Therefore, for a given treatment, mean values for the 28-day exposure period were used to conduct the linear regressions. In the case of pore water, measurements were performed on each sediment sample prior to test initiation and from one randomly selected replicate within each treatment on day 28 of the toxicity tests. Because no pore water or insufficient pore water was recovered from four of the SWMU 2 sediment samples upon receipt by the toxicity testing laboratory (2B-EWSD09, 2B-EWSD16, 2B-EWSD18, and 2B-EWSD24), only pH, salinity, and total ammonia data for measurements conducted on day 28 of the toxicity tests were used in the evaluation. Variables with little or no variability (i.e., sulfide in overlying water and pore water) were excluded from the linear regression analysis.

NCSS output pages for each regression are included within Appendix K. Results of the linear regressions are summarized in Table 4-37 (r and r^2 values; see Section 4.2.2.3 for a description of each value). As evidenced by Appendix K and Table 4-37, the linear regression analysis indicated that the ecological COCs copper, lead, and zinc did not have a significant influence on amphipod survival or dry weight per surviving amphipod. The following sediment and pore water variables also had no influence on amphipod survival or growth: sediment variables: mercury, SEM-to-AVS ratios, total ammonia, sulfide, TOC, ammonia, sulfide, TOC, and grain size characteristics (percent gravel, percent sand, and percent fines); pore water variables: salinity, total ammonia, and pH on day 28. However, sediment pH and overlying water salinity, total ammonia, and pH had a significant influence on amphipod survival, while sediment pH and overlying water total ammonia and pH had a significant influence on amphipod growth. The regression reports for these variables show the following relationships:

- Amphipod survival and growth decreased as sediment pH increased
- Amphipod survival and growth decreased as overlying water pH increased
- Amphipod survival and growth increased as overlying water total ammonia increased
- Amphipod survival increased as overlying water salinity increased.

As evidenced by the NCSS output pages for linear regressions performed on the survival endpoint (see Appendix K), p values (i.e., significance levels) for copper, lead, and zinc were only slightly elevated above the Type 1 error rate (i.e., α value [0.05]): copper = 0.1166; lead = 0.1112; and zinc = 0.0667. To further evaluate the relationship between copper, lead, mercury, and zinc concentrations in sediment, sediment pH, overlying water pH, salinity, and total ammonia, and amphipod survival in the toxicity tests, a multiple regression analysis was performed using NCSS software. Initially, the All Possible Regressions variable selection routine was run with the following independent variables: copper, lead, mercury, zinc, sediment pH, and overlying water pH, salinity, and total ammonia. As discussed in Section 4.2.2.3, the variable selection routine was run to (1) identify every independent variable that is even remotely related to the dependent variable (survival) and (2) eliminate those independent variables that are irrelevant since their inclusion would decrease the precision of the multiple regression analysis.

NCSS printouts showing the results of the variable selection routine are included as Appendix K. Based on the eight independent variables selected, 288 separate models were run for the evaluation of survival. Plots showing the number of independent variables in each model versus r^2 values were examined to determine the point at which the increase in the r^2 value with the addition of an independent variable levels off (i.e., a plateau in the curve is achieved). The r^2 versus variable count plot for survival indicates that beyond the inclusion of three variables in the model, r^2 values do not increase substantially. The model with three independent variables having the highest r^2 value (0.9365) includes copper, lead, and sediment pH. It is noted that there is little difference among r^2 values for many of the three independent variable models (r^2 values range from 0.8633 to 0.9365). Sediment pH is the only variable included in all ten of the most explanatory models (i.e., models with three independent variables having the highest r^2 values). Based on the independent variables identified by examination of the variable selection routine, a multiple regression was run to determine if the model selected for analysis had a significant influence on amphipod survival. NCSS printouts showing the results of the multiple regressions, included within Appendix K, show that the three independent variable model for survival was significant ($p = 0.0005$). Within the model, copper and sediment pH had a significant influence on amphipod survival ($p = 0.0317$ and 0.0002 , respectively).

The literature indicates that changes in toxicity with respect to pH are generally metal- and organism-specific. Research conducted by the USEPA Office of Research and Development indicates that copper toxicity to amphipods decreases with decreasing pH, while the toxicities of cadmium, lead, nickel, and zinc remained constant (USEPA, 1997c). Taking into consideration the results of the linear regressions, which demonstrated that amphipod survival decreased with increasing pH, and the results of the multiple regression, which demonstrated that copper and pH have a significant influence on amphipod survival, it can be concluded that the bioavailability and toxicity of copper is being influenced by sediment pH. However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured sediment trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in sediment and amphipod survival in the toxicity tests. Therefore, the *Leptocheirus plumulosus* toxicity test results could not be used to establish site-specific NOAELs for benthic invertebrate direct contact exposures to ecological COCs in SWMU 2 estuarine wetland sediment.

Due to zero percent survival in four sediment samples (2B-EWSD09, 2B-EWSD15, 2B-EWSD18, and 2B-EWSD24) and insufficient biomass at test termination in a fifth sediment sample (2B-EWSD12) (see Table 4-36), growth data were available for only five of the ten sediment samples submitted for *Leptocheirus plumulosus* toxicity testing. Because the All Possible Regressions variable selection procedure requires two data points more than the number of independent variables evaluated, only three independent variables could be selected for inclusion into the variable selection

procedure. For this reason, the All Possible Regression variable selection routine and multiple regression analysis were not performed for the amphipod growth endpoint.

4.2.6.2 Polychaete Toxicity Tests

The 20-day *Neanthes arenaceodentata* survival and growth tests were conducted in accordance with ASTM Standard E 1562-00: *Standard Guide for Conducting Acute, Chronic, and Life-Cycle Aquatic Toxicity Tests with Polychaetous Annelids* (ASTM, 2006b). Test endpoints for *Neanthes arenaceodentata* were survival, calculated as the percentage of test organisms at test initiation that survived at test termination; and growth, calculated as mean dry weight per surviving polychaete at test termination. The laboratory's toxicity report (included as Appendix E) summarizes the methodology used to conduct the *Neanthes arenaceodentata* toxicity tests. No protocol deviations from ASTM Standard E 1562-00 were recorded during the performance of the tests. It is noted that each SWMU 2 and reference area sediment sample was tested using eight replicates, with 10 polychaetes per replicate. To prevent possible cannibalism, polychaetes assigned to a given replicate were tested individually (i.e., one organism per test chamber, with ten test chambers per replicate). ASTM (2006b) methodology recommends a minimum of ten organisms per treatment, with organisms in a treatment divided between at least two replicates. A total of eight replicates were tested per sediment sample in an attempt to increase the power of the toxicity tests by reducing the between-replicate (i.e., inter-replicate) variability of each endpoint.

Table 4-38 presents a summary of the toxicity test results and associated analytical data. Included in the table are results of the various overlying water and pore water measurements performed by the toxicity testing laboratory. Total ammonia, pH, salinity, and sulfide measurements were conducted on pore water extracted from each SWMU 2 and reference area sediment sample prior to test initiation and again from a single replicate of each treatment at test termination. Dissolved oxygen, pH, salinity, sulfide, temperature, and total ammonia measurements were conducted on overlying water. Temperature and dissolved oxygen were measured on a daily basis throughout the tests, pH was measured at test initiation and on days 1, 2, 3, 4, 5, 13, and 20 of the toxicity tests (i.e., three times per week), while sulfide and total ammonia were measured at test initiation and on days 5, 13, and 20. The overlying water analytical results included in Table 4-38 are limited to pH, salinity, total ammonia, and sulfide results for Day 0 (i.e., test initiation) and Day 28 (test termination). Results for the daily temperature and dissolved oxygen measurements, as well as results for the pH measurements conducted on days 1, 2, 3, 4, 5, 13 and the salinity, sulfide, and total ammonia measurements conducted on days 5 and 13 are included within the testing laboratory's toxicity report (see Appendix E). The sections that follow provide a discussion and analysis of the *Neanthes arenaceodentata* toxicity data.

4.2.6.2.1 *Comparison of Biological Responses in SWMU 2 Estuarine Wetland Sediment to Biological Responses in Estuarine Wetland Reference Area Sediment*

Neanthes arenaceodentata survival and growth data were analyzed by the testing laboratory using SigmaStat® Version 2.03 statistical software (SPSS Inc., Chicago, IL). Statistical comparisons were made against the following test endpoints:

- Polychaete survival (percent) in each replicate at test termination
- Dry weight per surviving polychaete in each replicate at test termination

The survival and growth (i.e., dry weight) data were subjected to hypothesis testing to determine if measured biological responses in SWMU 2 and reference area sediment samples are equal. Initially,

normality and homogeneity of variance were tested at an alpha (α) of 0.05 using D'Agostino's test and Bartlett's test, respectively. D'Agostino's test was used instead of the Shapiro-Wilks test based on $N > 50$. Given that the assumption of normality or homogeneity passed for each test endpoint evaluated, parametric ANOVA tests were performed on the ranked data (tested at an α of 0.05). The ANOVA tested the null hypothesis that all means of each treatment, including the reference sediments, are equal. When a statistically significant difference was detected for a given endpoint (i.e., differences in values among the treatments are greater than would be expected by chance), as was the case for the each test endpoint evaluated, a multiple comparison procedure (Bonferroni t-test) was run to isolate the specific treatments that differ. For a given endpoint, separate multiple comparison procedures were performed against each reference area sediment sample. All statistical evaluations performed by the toxicity testing laboratory are included within Appendix E.

Evaluation of Toxicity Test Negative Control and Reference Sediments

A negative control was run concurrently with the SWMU 2 and estuarine wetland reference area sediment samples to ensure that the population of test organisms used in the toxicity tests was healthy. Sediment used for the negative control was laboratory reference sediment. Identical to the *Leptocheirus plumulosus* toxicity tests, overlying water for the negative control, as well as the SWMU 2 and estuarine wetland reference area sediment samples tested for toxicity, was reconstituted seawater prepared by adding Instant Ocean® to dechlorinated tap water (tap water was dechlorinated using the procedures presented in Section 4.2.2.1.1). Minimum acceptable performance for the negative control is specified as 80 percent or greater survival on day 20 (ASTM, 2006b). As evidenced by Table 4-38, mean control survival was 82.50 percent with an inter-replicate survival range of 70 to 90 percent. Although not specified by ASTM Standard E 1562-00 as a requirement for determination of test acceptability, control organisms also showed evidence of growth during the toxicity tests. The mean dry weight of 26 randomly selected polychaetes at test initiation was 0.1542 mg/organism (see Appendix E), while mean dry weight of surviving polychaetes at test initiation was 2.1628 mg/organism. Based on these data, it is concluded that the polychaete population used as test organisms for toxicity testing were healthy and toxicity test results are valid.

Two sediment samples were collected from the estuarine wetland reference area and tested concurrently with the SWMU 2 sediment samples (2B-REF-EWSD01 and 2B-REF-EWSD02). These samples were collected to provide a site-specific basis for evaluating toxicity (survival and growth in SWMU 2 sediment samples were statistically compared to survival and growth in each reference area sediment sample). Mean survival of test organisms exposed to 2B-REF-EWSD01 was 73.75 percent, while mean survival of test organisms exposed to 2B-REF-EWSD02 was 52.50 percent. Polychaete survival in each reference sediment sample did not meet the minimum acceptable performance criteria established by ASTM Standard E 1562-00 for test organism survival in the negative control (80 percent or greater survival on day 20). Since the purpose of the reference sediment samples was to provide a site-specific basis for evaluating toxicity by assessing sediment conditions exclusive of the ecological COCs, low survival in the reference sediments does not invalidate the toxicity test results.

Survival

The one-way ANOVA on ranks detected a significant difference in amphipod survival (arcsine square root transformed data) among treatment groups ($p < 0.001$). The follow-on multiple comparison procedure (Bonferroni t-test) identified a significant decrease in mean survival by polychaetes exposed to the 2B-EWSD09 sediment sample (mean survival = 26.25 percent) relative to reference sediment sample 2B-REF-EWSD01 (mean survival = 73.75 percent) (see Appendix E and Table 4-38). A review of the analytical data presented in Table 4-38 shows that this sediment sample

exhibited the highest SEM-to-AVS ratio (161.4). This sediment sample also contained high copper, lead, and zinc molar concentrations (i.e., molar concentrations greater than the molar concentration of AVS), as well as high copper, lead, and zinc bulk sediment concentrations (i.e., concentrations greater than sediment screening values). These data indicate that polychaetes may have been exposed to toxic concentrations of copper, lead, and/or zinc in 2B-EWSD09 pore water. The significant reduction in survival by polychaetes exposed to sediment sample 2B-EWSD09 relative to reference area sediment sample 2B-REF-EWSD01 is a line of evidence supporting unacceptable risk to benthic invertebrates from SWMU 2 estuarine wetland sediment.

Growth

The one-way ANOVA on ranks detected a significant difference in polychaete growth (dry weight) among treatment groups ($p < 0.001$). The follow-on multiple comparison procedures (Bonferroni t-test) detected a significant difference in growth in SWMU 2 sediment samples 2B-EWSD15 and 2B-EWSD24 and reference area sediment sample 2B-REF-EWSD02. However, the statistical difference detected by Bonferroni t-test represents a significant increase in growth by polychaetes exposed to SWMU 2 sediment samples 2B-EWSD15 and 2B-EWSD24 relative to growth by polychaetes exposed to reference area sediment sample 2B-REF-EWSD02 (mean dry weight per surviving polychaete in 2B-EWSD15 and 2B-EWSD24 was 6.4067 mg and 6.0443 mg, respectively, while mean dry weight of surviving polychaetes in 2B-REF-EWSD02 was 3.6856 mg). The absence of a significant reduction in growth by polychaetes exposed to SWMU 2 sediment is a line of evidence supporting minimal risk on this test endpoint.

4.2.6.2.2 *Evidence of a Significant Correlation between Laboratory Toxicity Test Results and the Chemical/Physical Characteristics of Sediment*

As discussed in the preceding section, the statistical procedures performed by the testing laboratory indicated that survival in 2B-EWSD-09 was significantly reduced relative to survival in reference area sediment sample 2B-REF-EWSD-01. NCSS statistical and power analysis software [<http://www.ncss.com>] was used to run pair-wise linear regressions that examined the relationship between polychaete survival and the chemical/physical characteristics of the sediments. The following sediment variables were included in the analysis: copper, lead, and zinc (ecological COCs identified in Step 3a of the ERA process for benthic invertebrate direct contact exposures [Baker, 2006a]), mercury, SEM-to-AVS ratios, total ammonia, sulfide, pH, TOC, and grain size characteristics (percent gravel, percent sand, and percent fines [silt and clay]). In addition to the sediment variables identified above, the linear regression analysis included the following overlying water and/or pore water parameters: pH, salinity, sulfide, and total ammonia. In the case of overlying water, these parameters were measured on multiple days during the performance of the toxicity tests (see Section 4.2.6.2). Therefore, for a given treatment, mean values for the 20-day exposure period were used to conduct the linear regressions. In the case of pore water, measurements were performed on each sediment sample prior to test initiation and from one randomly selected replicate within each treatment on day 20 of the toxicity tests. As discussed in Section 4.6.2.2, no pore water or insufficient pore water was recovered from four of the SWMU 2 sediment samples upon receipt by the toxicity testing laboratory (2B-EWSD09, 2B-EWSD16, 2B-EWSD18, and 2B-EWSD24). Therefore, only pH, salinity, sulfide, and total ammonia data for measurements conducted on day 20 of the toxicity tests were used in the evaluation. Variables with little or no variability (i.e., sulfide in overlying water) were excluded from the linear regression analysis.

NCSS output pages for each regression are included within Appendix L. Results of the linear regressions are summarized in Table 4-39 (r and r^2 values; see Section 4.2.2.3 for a description of each value). As evidenced by Appendix L and Table 4-39, the linear regression analysis indicated

that the ecological COCs copper, lead, and zinc did not have a significant influence on polychaete survival. The following sediment, overlying water, and pore water variables also had no influence on polychaete survival: sediment mercury, total ammonia, sulfide, TOC, percent gravel, and percent fines; overlying water salinity, total ammonia, and pH; pore water salinity, sulfide, total ammonia, and pH. However, SEM-to-AVS ratios and the percent sand content of sediment had a significant influence on polychaete survival. The regression reports for these two variables show the following relationships:

- Polychaete survival decreased as the SEM-to-AVS ratio increased
- Polychaete survival decreased as the percent sand content of sediment increased

The importance of AVS in controlling the bioavailability and toxicity of SEM metals, including copper, lead, and zinc, has been extensively validated by the literature (Ankley, 1996, Ankley et al., 1996, Berry et al., 1996, Hansen et al., 1996, and Long et al., 1997). Grain size characteristics also represent potential confounding factors in toxicity tests (Lapota et al., 2000).

To further evaluate the relationship between copper, lead, mercury, zinc and AVS concentrations in sediment, the percent sand content of sediment, and polychaete survival in the toxicity tests, a multiple regression analysis was performed using NCSS software. Initially, the All Possible Regressions variable selection routine was run with the following independent variables: copper, lead, mercury, zinc, SEM-to-AVS ratio, and percent sand. As discussed in Section 4.2.2.3, the variable selection routine was run to (1) identify every independent variable that is even remotely related to the dependent variable (survival), and (2) eliminate those independent variables that are irrelevant since their inclusion would decrease the precision of the multiple regression analysis.

NCSS printouts showing the results of the variable selection routine are included as Appendix L. Based on the eight independent variables selected, 64 separate models were run for the evaluation of survival. Plots showing the number of independent variables in each model versus r^2 values were examined to determine the point at which the increase in the r^2 value with the addition of an independent variable levels off (i.e., a plateau in the curve is achieved). The r^2 versus variable count plot for survival indicates that beyond the inclusion of four variables in the model, r^2 values do not increase substantially. The model with four independent variables having the highest r^2 value (0.8129) includes copper, lead, SEM-to-AVS ratio, and percent sand. It is noted that there is little difference among r^2 values for many of the four independent variable models (r^2 values range from 0.6906 to 0.8129). SEM-to-AVS ratio is the only variable included in all ten of the most explanatory models (i.e., models with four independent variables having the highest r^2 values). Based on the independent variables identified by examination of the variable selection routine, a multiple regression was run to determine if the model selected for analysis had a significant influence on polychaete survival. NCSS printouts showing the results of the multiple regressions, included within Appendix L, show that the four independent variable model for survival was significant ($p = 0.0459$). Within the model, SEM-to-AVS ratio had a significant influence on polychaete survival ($p = 0.0368$). As evidenced by the NCSS output pages for the multiple regression, p values (i.e., significance levels) for copper and lead were only slightly elevated above the Type 1 error rate (i.e., α value [0.05]): 0.0809 for copper and 0.0595 for lead).

Taking into consideration the results of the linear regressions, which demonstrated that polychaete survival decreased with increasing SEM-to-AVS ratios, and the results of the multiple regression, which demonstrated that the SEM-to-AVS ratio of sediment has a significant influence on polychaete survival, it can be concluded that the bioavailability and toxicity of copper and lead is being influenced by sediment AVS concentrations. However, this modifying factor, as well as other factors

such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured sediment trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in sediment and polychaete survival in the toxicity tests. Therefore, the *Neanthes arenaceodentata* toxicity test results could not be used to establish site-specific NOAELs for benthic invertebrate direct contact exposures to ecological COCs in SWMU 2 estuarine wetland sediment.

4.2.7 Fiddler Crab Tissue

A total of eight whole-body fiddler crab tissue samples (2B-FC01 through 2B-FC08) were collected during BERA field investigation in order to evaluate potential risks to avian invertivores that may forage within the estuarine wetland downgradient from SWMU 2 (see Table 3-5). As discussed in Section 3.2.6 and depicted on Figure 3-11, the SWMU 2 estuarine wetland coastline was divided into four equal segments based on linear feet of coastline. Two fiddler crab composite samples were collected from each segment (tissue samples 2B-FC01 and 2B-FC02 were collected from Wetland Segment No. 1, 2B-FC03 and 2B-FC04 were collected from Wetland Segment No. 3, 2B-FC05 and 2B-FC06 were collected from Wetland Segment No. 2, and 2B-FC07 and 2B-FC08 were collected from Wetland Segment No. 1). In addition to the SWMU 2 tissue samples, a total of four fiddler crab tissue samples were collected from the estuarine wetland reference area (2B-REF-FC01 through 2B-REF-FC04). Each SWMU 2 and reference area tissue sample was analyzed for lead, mercury, and percent lipids using the methodology summarized in Table 3-6. Lead and mercury represent the ecological COCs identified in Step 3a of the ERA process at SWMU 2 for avian invertivore dietary exposures (Baker, 2006a).

4.2.7.1 Fiddler Crab Tissue Analytical Results

Fiddler crab tissue data were used to evaluate potential risks to aquatic avian invertivores that may forage within the estuarine wetland at SWMU 2. The SWMU 2 and Open Water Reference Area No. 2 fiddler crab tissue analytical results are presented in Tables 4-40 (SWMU 2) and 4-41 (Reference Area No. 2). Analytical results for each sample are reported as wet-weight and dry-weight concentrations. The analytical laboratory did not report the percent solids content of the fiddler crab tissue samples. Therefore, the dry-weight concentrations presented in Tables 4-40 and 4-41 were estimated by dividing wet-weight concentrations by the approximate solids content of crabs with shells (0.26 percent [0.16]; USEPA, 1993).

As evidenced by the dry-weight analytical data presented in Table 4-40, mercury was detected in each SWMU 2 fiddler crab tissue sample, while lead was detected in six of seven (6/7) fiddler crab tissue samples. Detected lead concentrations ranged from 0.46J mg/kg in 2B-FC08 to 16 mg/kg in 2B-FC03 and 2B-FC04. Detected mercury concentrations ranged from 0.032J mg/kg in 2B-FC02 to 0.31 mg/kg in 2B-FC04. Fiddler crab tissue samples containing maximum lead and mercury concentrations were collected from Section No. 3 (2B-FC03 and 2B-FC04). A review of the analytical data presented in Table 2-11 for sediment collected during the 2003 and 2004 additional data collection field investigations shows that maximum lead and mercury concentrations were detected in 2EWSD12. Based on sampling locations relative to the wetland section boundaries established for fiddler crab sampling activities (see Figure 3-11), the 2EWSD12 sediment samples was collected within Section No. 3. Maximum concentrations also were detected in sediment collected from Section No. 3 during the BERA field investigation (lead: 450J mg/kg in 2B-EWSD18; mercury: 0.81 mg/kg in 2B-EWSD16 [see Table 4-40]). These data clearly indicate that maximum lead and mercury tissue and sediment concentrations are co-located with Section No. 3.

4.2.7.2 Comparison of Spotted Sandpiper Dietary Intakes at SWMU 2 to Ingestion-Based Toxicity Reference Values

Spotted sandpiper dietary intakes at SWMU 2 were estimated using the following formula modified from USEPA (1993):

$$DI_x = \frac{[\sum_i [(FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)]] [AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg-BW/day)
FIR	=	Mean food ingestion rate (kg/day, dry-weight)
FC_{xi}	=	95 percent UCL of the mean concentration of chemical x in food item i (mg/kg, dry weight)
PDF_i	=	Proportion of diet composed of food item i (unitless; dry weight basis)
SC_x	=	95 percent UCL of the mean concentration of chemical x in surface sediment (mg/kg, dry weight)
PDS	=	Proportion of diet composed of sediment (unitless; dry weight basis)
BW	=	Mean body weight (kg, wet weight)
AUF	=	Area Use Factor (unitless)

The spotted sandpiper was used as a representative species for aquatic avian invertivores at SWMU 2. As outlined in Section 2.5.4, exposure parameters used for the spotted sandpiper included a mean food ingestion rate of 0.00804 kg/day-dry weight (allometric equation from Nagy 2001 for all birds) and a mean body weight of 0.0404 kg (Dunning, 1993). The exposure diet was assumed to be 81.9 percent aquatic invertebrates (USEPA, 1993) and 18.1 percent sediment (Beyer et al, 1994). As discussed for the American robin, direct ingestion of drinking water is only considered if the salinity of a drinking water source is less than 15 ppt, the approximate toxic threshold for wildlife receptors (Humphreys, 1988). No potential drinking water sources are located within or contiguous to SWMU 2; therefore, ingestion of surface water is not a complete exposure pathway and was not considered in risk calculations for dietary exposures. Finally, it was assumed that the spotted sandpiper spends 100 percent of its time within the estuarine portions of SWMU 2 (i.e., an AUF of 1.0 was assumed).

The Final Steps 3B and 4 Report (Baker, 2007) specified that 95 percent UCL of the mean fiddler crab tissue concentrations would be used in the dietary intake equation were 95 percent UCL of the mean concentrations calculated using USEPA ProUCL Version 4.0.04 software (USEPA, 2009a and 2009b; see Appendix M). For a given ecological COC, when more than one 95 percent UCL of the mean concentration was calculated and recommended by USEPA ProUCL Version 4.0.04 software, the maximum value was conservatively selected for the estimation of dietary intakes. Sediment concentrations used in the dietary intake equation also were 95 percent UCL of the mean concentrations derived for the data set summarized in Tables 2-11 and 4-30 (data set for sediment samples collected during the 2003 additional data collection investigation, 2004 additional data collection report, and BERA field investigation; see Table 4-32 and Appendix J). Chemical-specific 95 percent UCL of the mean fiddler crab tissue and estuarine wetland sediment concentrations for lead and mercury are summarized below.

- 95 percent UCL of the mean fiddler crab tissue concentrations (dry weight basis): 15.38 mg/kg for lead and 0.174 mg/kg for mercury (see Appendix M)

- 95 percent UCL of the mean sediment concentrations: 96.8 mg/kg for lead and 0.262 mg/kg for mercury (see Table 4-32 and Appendix J)

Ingestion-based risk estimates (i.e., HQ values) for the spotted sandpiper were calculated by dividing dietary intakes by the literature-based NOAEL, MATC, and LOAEL values summarized in Table 2-14. Sample et al. (1996) consider a scaling factor of 1.0 most appropriate for interspecies extrapolation between birds. Therefore, the NOAEL and LOAEL values summarized in Table 2-13 were not adjusted to reflect differences in body weights between avian test species and avian receptor species. As discussed in Section 2.5.4, it was conservatively assumed that all mercury at SWMU 2 is present as methylmercury. Therefore, 95 percent UCL of the mean HQ values were derived using the NOAEL, MATC, and LOAEL values from the study using methylmercury dicyandiamide as the test material (see Table 2-14).

Risk estimates for spotted sandpiper dietary exposures to lead and mercury in SWMU 2 estuarine wetland sediment are summarized in Table 4-42. As evidenced by the table, both lead and mercury NOAEL-based HQs calculated using 95 percent UCLs of the mean sediment and fiddler crab tissue concentrations are greater than 1.0 (3.68 for lead and 1.45 for mercury). MATC- and LOAEL-based risk estimates for lead also exceed 1.0 (MATC-based HQ = 2.60; LOAEL-based HQ = 1.84), while MATC-based and LOAEL-based risk estimates for mercury are less than 1.0 (MATC-based HQ = 0.84; LOAEL-based HQ = 0.48). Because lead HQ values for each ingestion-based TRV (NOAEL-, MATC-, and LOAEL-based TRVs) exceed 1.0, it is concluded that lead is bioaccumulating within invertebrate tissue at concentrations that could impact aquatic avian invertivore populations that feed exclusively on invertebrates within the estuarine wetland habitat at SWMU 2. In the case of mercury, a MATC-based HQ value less than 1.0 indicates that this metal is not bioaccumulating within invertebrate tissue at concentrations that would impact aquatic avian invertivore populations (NOAELs are artifacts of dose selection and do not represent actual threshold effects).

4.2.7.3 Comparison of Spotted Sandpiper Dietary Intakes at the Estuarine Wetland Reference Area to Ingestion-Based Toxicity Reference Values

To determine if potential risks presented by lead to aquatic avian invertivore populations at SWMU 2 are site-related, risk estimates also were derived for spotted sandpiper dietary exposures to this metal at the estuarine wetland reference area. Based on the low number of tissue and sediment samples collected at the estuarine wetland reference area during the BERA field investigation (four tissue samples and six sediment samples), 95 percent UCL of mean tissue and sediment concentrations were not calculated. Therefore, estuarine wetland reference area risk estimates for lead were derived using maximum sediment and fiddler crab tissue concentrations from Tables 4-31 and 4-41, respectively (maximum sediment concentration = 8.4J mg/kg in 2B-REF-EWSD06); maximum fiddler crab tissue concentration [dry weight basis] = 1.1 mg/kg in 2B-REF-FC01).

Maximum HQ values for spotted sandpiper dietary exposures at the estuarine wetland reference area are presented below.

- Maximum NOAEL-based HQ: 0.31
- Maximum MATC-based HQ: 0.22
- Maximum LOAEL-based HQ: 0.15

The maximum HQ values listed above for the estuarine wetland reference area and the 95 percent UCL of the mean HQ values presented in Table 4-42 for SWMU 2 clearly show that potential risks presented by lead to avian invertivore populations at SWMU 2 are site-related.

4.2.8 Turtle Grass Tissue and Co-Located Sediment Samples

Whole-plant and above ground turtle grass tissue samples were collected from the open water portion of SWMU 2 in order to evaluate potential risks to West Indian manatees that may forage within the Ensenada Honda. A total of three whole-plant and three above ground composite samples were collected from the open water portion of SWMU 2 (see Table 3-5). As discussed in Section 3.2.7, specific locations were not targeted for sampling based on analytical chemistry (analytical data for sediment samples collected during the 2003 additional data collection field investigation indicate that ecological COCs exhibit a fairly uniform concentration distribution throughout the open water portion of SWMU 2). Instead, sample locations, depicted on Figure 3-12, selected based on the presence of turtle grass. Three whole-plant and three above ground turtle grass tissue samples also were collected from Open Water Reference Area No. 2 (see Table 3-5 and Figure 3-13). The SWMU 2 and Reference Area No. 2 turtle grass tissue samples were analyzed for arsenic, cadmium, copper, lead, mercury, selenium, and zinc using the methodology summarized in Table 3-6. Arsenic, cadmium, copper, lead, mercury, selenium, and zinc represent the ecological COCs identified in Step 2 of the ERA process for West Indian manatee food web exposures.

In addition to the turtle grass tissue samples, a single sediment sample was collected at each SWMU 2 and reference area turtle grass tissue sampling location (see Table 3-5). The co-located sediment samples were analyzed for arsenic, cadmium, copper, lead, mercury, selenium, zinc, TOC, and grain size using the methodology summarized in Table 3-6. As outlined in the Final Steps 3b and 4 Report (Baker, 2007) and Section 3.2.7, analytical data for the SWMU 2 open water sediment samples were evaluated to determine if the turtle grass tissue samples were collected from areas representative of the range of sediment concentrations observed within the Ensenada Honda during the 2003 additional data collection field investigation (open water sediment data used in the SERA and Step 3a of the BERA [Baker, 2006a]). If ecological COC concentrations in co-located sediment samples are representative of previously reported concentrations, it can be concluded that concentrations in turtle grass tissue samples collected during the BERA field investigation are representative of ecological COC concentrations in turtle grass tissue throughout the open water portion of SWMU 2. Such a conclusion assumes that the only factor affecting arsenic, cadmium, copper, lead, mercury, selenium, and zinc bioaccumulation in turtle grass tissue is their concentration in sediment.

4.2.8.1 Turtle Grass Tissue and Co-Located Sediment Sample Analytical Results

The SWMU 2 and Open Water Reference Area No. 2 whole-plant and above ground turtle grass tissue analytical results are presented in Tables 4-43 (SWMU 2) and 4-44 (Reference Area No. 2). Although analytical data were reported on a wet-weight basis by the laboratory, the tables include both wet-weight and dry-weight concentrations. For a given sample and analyte, the dry-weight concentration was derived by dividing the wet-weight concentration by the solids content of that sample (i.e., fraction of sample that is solids). Dry-weight concentrations were calculated since the estimation of West Indian manatee dietary intakes (presented in Section 4.2.8.2) uses exposure parameters expressed on a dry-weight basis.

As evidenced by the dry-weight analytical data presented in Table 4-43, mercury and selenium and mercury were not detected in any of the SWMU 2 turtle grass tissue samples (whole-plant or above ground samples). Lead was detected two whole-plant tissue concentrations (1.5J mg/kg in 2B-SG02-WP and 2.5J mg/kg in 2B-SG03-WP). This metal also was detected in each above ground tissue

sample at concentrations ranging from 2.2J mg/kg (2B-SG02-AG) to 3.6J mg/kg (2B-SG03-AG). Arsenic, cadmium, copper, and zinc were detected in each SWMU 2 tissue sample. Arsenic concentrations in whole-plant tissue samples ranged from 5.1 mg/kg (2B-SG02-WP) to 6.0J mg/kg (2B-SG03-WP), while concentrations in above ground tissue samples ranged from 7.4 mg/kg (2B-SG01-AG) to 8.3 mg/kg (2B-SG03-AG). Cadmium concentrations in whole-plant tissue samples ranged from 0.34J mg/kg (2B-SG03-WP) to 0.44J mg/kg (2B-SG01-WP), while concentrations in above ground tissue samples ranged from 0.36J mg/kg (2B-SG03-AG) to 0.51J mg/kg (2B-SG01-AG). Copper concentrations in whole-plant tissue ranged from 13 mg/kg (2B-SG03-WP) to 17 mg/kg (2B-SG01-WP and 2B-SG02-WP), while concentrations in above ground tissue ranged from 19 mg/kg (2B-SG03-AG) to 24 mg/kg (2B-SG01-AG). Finally, zinc concentrations in whole-plant tissue ranged from 70 mg/kg (2B-SG03-WP) to 80 mg/kg (2B-SG02-WP), while concentrations in above ground tissue ranged from 99 mg/kg (2B-SG03-AG) to 129 mg/kg (2B-SG01-AG). The arsenic, cadmium, copper, lead, mercury, selenium, and zinc analytical data do not indicate that these seven metals are preferentially accumulating in above ground (i.e., leaf blades) or below ground (i.e., roots and rhizomes) portions of turtle grass tissue.

Identical to the SWMU 2 tissue samples, selenium was not detected in any of the Open Water Reference Area No. 2 whole-plant or above ground tissue samples (see Table 4-44). Mercury also was not detected in any of the above ground or whole-plant tissue samples collected from the open water reference area. Arsenic was detected in each above ground and whole-plant tissue sample. Concentrations in above-ground tissue samples ranged from 1.3J mg/kg (REF2-VEG-AB02) to 2.2J mg/kg (REF2-VEG-AB01), while whole-plant tissue concentrations ranged from 2.2J mg/kg (REF2-VEG-WB03) to 3.5J mg/kg (REF2-VEG-WB02). Cadmium and copper were detected in each above ground tissue sample and two of three whole-plant tissue samples. Cadmium concentrations in above ground tissue ranged from 0.17J mg/kg (REF2-VEG-AB02) to 0.27J mg/kg (REF2-VEG-AB01), while copper concentrations in above-ground tissue ranged from 3.8 mg/kg (REF2-VEG-AB02) to 4.6 mg/kg (REF2-VEG-AB01). Detected cadmium and copper concentrations in whole-plant tissue concentrations showed little variability (cadmium was detected in REF2-VEG-WB01 at 0.22J mg/kg and REF2-VEG-WB03 at 0.19J mg/kg, while copper was detected in REF2-VEG-WB01 at 3.8 mg/kg and REF2-VEG-WB03 at 3.0 mg/kg). Zinc was detected in two above ground tissue concentrations (30.0 mg/kg in REF2-VEG-AB01 and 27 mg/kg in REF2-VEG-AB03). This metal was not detected in any of whole-plant tissue samples. Finally, lead was detected in one whole-plant tissue sample (1.1J mg/kg in (REF2-VEG-WB02) and one above ground tissue sample (1.2J in REF2-VEG-AB01). The reference area turtle grass tissue analytical data do not indicate that arsenic, cadmium, copper, lead, mercury, selenium, or zinc are preferentially accumulating in above ground or below ground portions. These results are consistent with the above ground and whole-plant tissue analytical data for SWMU 2.

Analytical results for the co-located SWMU 2 and open water reference area sediment samples are presented in Tables 4-45 and 4-46, respectively. As discussed in Section 4.2.8, the co-located SWMU 2 sediment samples were collected to determine if turtle grass tissue was collected from areas representative of the range of sediment concentrations observed within the embayment during the 2003 additional data collection field investigation. The range of arsenic, cadmium, copper, lead, mercury, selenium, and zinc concentrations detected in sediment samples collected during the BERA field investigation and in sediment samples collected during the 2003 additional data collection field investigation (see Table 2-13) are presented within the table that follows.

Chemical	Detected Concentration Range: BERA Field Investigation (mg/kg)	Detected Concentration Range: 2003 Additional Data Collection Field Investigation (mg/kg)
Arsenic	6.2J – 9.7J	3.5 – 11
Cadmium	0.047J – 0.065J	0.091J
Copper	14J – 35J	8 – 19
Lead	2.6J – 4.2J	2.1 – 48
Mercury	0.015J – 0.027J	0.0094 – 0.034
Selenium	0.32J – 0.49J	0.27 – 0.51J
Zinc	19J – 24J	12 – 29

As evidenced by the table, arsenic, cadmium, mercury, selenium and zinc concentrations in sediment samples collected during the BERA field investigation are comparable to concentrations detected in sediment samples collected during the BERA field investigation. Therefore, it can be concluded that arsenic, cadmium, mercury, selenium, and zinc concentrations in the turtle grass tissue samples are representative of turtle grass tissue concentrations throughout the open water portion of SWMU 2. The analytical data presented in Table 4-45 indicate that copper was detected in a single sample at a concentration above the range of reported concentrations for sediment samples collected during the 2003 additional data collection field investigation (35J mg/kg in 2B-OWSD01). However, the dry-weight tissue data presented in Table 4-42 indicate that copper bioaccumulation in above ground and whole-plant turtle grass tissue collected at the 2B-OWSD01 is comparable to copper bioaccumulation at the other BERA sampling locations. Given that elevated bioaccumulation did not occur in tissue collected at the location where the maximum copper concentration was detected, it also can be concluded that copper concentrations in turtle grass tissue samples, including tissue samples collected at 2B-OWSD01, are representative of tissue concentrations throughout the open water portion of SWMU 2.

Lead concentrations detected in SWMU 2 open water sediment samples collected during the BERA field investigation are over an order of magnitude lower than the maximum lead concentration detected during the 2003 additional data collection field investigation. As such, lead concentrations in turtle grass tissue samples may not be representative of turtle grass tissue concentrations throughout the embayment. This is a source of uncertainty since risk estimates derived in Section 4.2.8.2 for this metal may understate potential risks to West Indian manatees that feed at locations within the embayment where lead concentrations are higher.

4.2.8.2 Comparison of West Indian Manatee Dietary Intakes at SWMU 2 to Ingestion-Based Toxicity Reference Values

West Indian manatee dietary intakes at SWMU 2 were estimated using the following formula modified from USEPA (1993):

$$DI_x = \frac{[(\sum_i [(FIR)(FC_{xi})(PDF_i))] + [(FIR)(SC_x)(PDS)]] [AUF]}{BW}$$

where:

DI_x = Dietary intake for chemical x (mg chemical/kg-BW/day)

<i>FIR</i>	=	Maximum food ingestion rate (kg/day, dry-weight)
<i>FC_{xi}</i>	=	Maximum concentration of chemical x in food item i (mg/kg, dry weight basis)
<i>PDF_i</i>	=	Proportion of diet composed of food item i (unitless; dry weight basis)
<i>SC_x</i>	=	Maximum concentration of chemical x in sediment (mg/kg, dry weight)
<i>PDS</i>	=	Proportion of diet composed of sediment (unitless; dry weight basis)
<i>BW</i>	=	Minimum body weight (kg, wet weight)
<i>AUF</i>	=	Area Use Factor (unitless)

As outlined in Section 2.5.4, exposure parameters used for the West Indian manatee included a maximum food ingestion rate of 21.9 kg/day-dry weight (Ethridge et al., 1985) and a minimum body weight of 800 kg (USGS, 2000a). These values were developed in the SERA (Baker, 2006a) and presented in the Final Steps 3b and 4 Report (Baker, 2007). The exposure diet was assumed to be 99 percent plant material (USFWS, 1986a and Odell, 1992) and 1 percent sediment (from incidental ingestion; USGS, 2000a). Ingestion of surface water is not a potential complete exposure pathway and was not considered in risk calculations for dietary exposures (see Section 2.5.4). Finally, it was assumed that the West Indian manatee spends 100 percent of its time within the open water portion of SWMU 2 (i.e., AUF of 1.0).

The analytical data for the whole-plant and above ground tissue samples (see Tables 4-43) indicate that turtle grass at SWMU 2 does not preferentially accumulate arsenic, cadmium, copper, lead, mercury, selenium, or zinc in above ground portions (i.e., leaf blades) or below ground portions (i.e., roots and rhizomes). As a measure of conservatism, dietary intakes were derived using maximum detected concentrations or, in the case of mercury and selenium (not detected in turtle grass tissue samples), maximum reporting limits for the above ground and whole-plant tissue samples (dry-weight basis). Maximum detected concentrations for co-located sediment collected during the BERA field investigation also were used in the dietary intake equation to account for incidental ingestion of sediment. The maximum turtle grass and sediment concentrations used to estimate dietary intakes are summarized below.

- Maximum Turtle Grass Tissue Concentrations (dry weight basis): 8.3 mg/kg for arsenic, 0.51J mg/kg for cadmium, 24 mg/kg for copper, 3.6J mg/kg for lead, 0.066U for mercury, 1.6U mg/kg for selenium, and 129 mg/kg for zinc (see Table 4-43)
- Maximum Sediment Concentrations: 9.7J mg/kg for arsenic, 0.065J mg/kg for cadmium, 35J mg/kg for copper, 4.2J mg/kg for lead, 0.027J mg/kg for mercury, 0.49J mg/kg for selenium, and 24J mg/kg for zinc (see Table 4-45)

Ingestion-based HQs for the West Indian manatee were calculated by dividing maximum dietary intakes by literature-based NOAEL, MATC, and LOAEL values adjusted to reflect differences in body weights between mammalian test species and the West Indian manatee. Test species NOAEL, MATC, and LOAEL values, as well as adjusted values used in the derivation of maximum arsenic, cadmium, copper, mercury, selenium, and zinc HQ values are summarized in Table 2-15. As discussed in Section 2.5.4, it was conservatively assumed that all mercury at SWMU 2 is present as methylmercury. Therefore, mercury HQ values were derived using the NOAEL, MATC, and LOAEL value from the study using methylmercury chloride as the test material (see Table 2-15). Based on the endangered species status of the West Indian manatee, NOAEL values are most appropriate for this receptor. As such, conclusions regarding the acceptability of risk are based on HQ values derived using NOAEL values.

Maximum HQ values for West Indian manatee dietary exposures at SWMU 2 are summarized in Table 4-47. Although MATC- and LOAEL-based HQ values were not considered when determining

acceptability of risk, these values are presented in Table 4-47 to provide a range of potential risks to this receptor. As evidenced by the table, arsenic, cadmium, copper, lead, mercury, selenium, and zinc NOAEL-based HQ values using maximum SWMU 2 turtle grass and sediment concentrations are less than 1.0 (HQ = 0.65 for arsenic, 0.12 for cadmium, 0.20 for copper, 0.09 for lead, 0.64 for mercury, 0.79 for selenium, and 0.63 for zinc). The NOAEL-based HQ values indicate that these seven metals are not bioaccumulating in turtle grass at concentrations that would impact West Indian manatees that feed exclusively on turtle grass within the open water portion of SWMU 2. Because the evaluation did not detect any unacceptable risks to West Indian manatees feeding exclusively at SWMU 2, risk estimates for West Indian manatees feeding exclusively at the open water reference area were not derived.

As discussed in Section 4.2.8.1, lead concentrations detected in sediment samples collected during the BERA field investigation (3.8J mg/kg in 2B-OWSD01, 2.6J mg/kg in 2B-OWSD02, 3.2J mg/kg in 2B-OWSD02D, and 4.2J mg/kg in 2B-OWSD03) are over an order of magnitude less than the maximum concentration detected during the 2004 additional data collection field investigation (48 mg/kg in 02OWSD04; see Table 2-13). If the only factor influencing lead bioaccumulation in turtle grass tissue is the concentration of lead in sediment, the risk estimate for this metal may understate actual risks to the West Indian manatees. The uncertainty associated with the lead risk estimate for West Indian manatee dietary exposures is addressed in Section 7.0.

5.0 RISK CHARACTERIZATION

The potential for risk to terrestrial invertebrates (from direct contact exposures) and avian omnivores (from dietary exposures) to ecological COCs in SWMU 2 soil (surface and subsurface soil), benthic invertebrates (from direct contact exposures) and avian invertivores (from food web exposures) to ecological COCs in SWMU 2 estuarine wetland sediment, and West Indian manatees (from dietary exposures) to ecological COCs in open water sediment is characterized within the sections that follow.

The general risk questions that focused the BERA for SWMU 2 are listed below.

- Are ecological COC concentrations in SWMU 2 soil high enough to impair the survival, growth, or reproduction of terrestrial invertebrate communities?
- Are ecological COC concentrations in SWMU 2 soil high enough to impair the survival, growth, and reproduction of terrestrial avian omnivore populations?
- Are ecological COC concentrations in SWMU 2 estuarine wetland sediment high enough to impair the survival, growth, or reproduction of aquatic invertebrate communities?
- Are ecological COC concentrations in SWMU 2 estuarine wetland sediments high enough to impair the survival, growth, and reproduction of avian invertivores?
- Are ecological COC concentrations in SWMU 2 open water sediments high enough to adversely affect the survival, growth, or reproduction of West Indian manatees?

The lines of evidence considered in the evaluation of these risk questions were:

Terrestrial invertebrates:

- Comparison of antimony, copper, lead, mercury, and zinc concentrations in soil to invertebrate-based screening values
- Comparison SWMU 2 and reference area toxicity test results from 28-day *Eisenia fetida* survival, growth, and reproduction tests
- Evidence of a significant correlation between laboratory toxicity test results and the chemical/physical characteristics of soil for those *Eisenia fetida* test endpoints in which an overall significant negative result was measured

Terrestrial avian omnivores:

- Comparison of antimony, copper, lead, mercury and zinc dietary intakes using tissue data for earthworms maintained in SWMU 2 and reference area soil during toxicity testing to ingestion-based TRVs (although antimony was not identified as an ecological COC in Step 3a of the BERA for terrestrial avian omnivore dietary exposures, this metal was included in the evaluation of this line of evidence since the maximum detected concentration was measured in soil collected during the BERA field investigation)

Estuarine wetland benthic invertebrates:

- Comparison of copper, lead, mercury and zinc concentrations in sediment to sediment screening values (although mercury was not identified as an ecological COC in Step 3a of the BERA for benthic invertebrate communities, this metal was included in the evaluation of this line of evidence since the maximum detected concentration was measured in sediment collected during the BERA field investigation)
- Comparison of SEM sediment concentrations to AVS sediment concentrations
- Comparison of SWMU 2 and reference area toxicity test results from 28-day *Leptocheirus plumulosus* survival, growth and reproduction tests and 20-day *Neanthes arenaceodentata* survival and growth tests
- Evidence of a significant correlation between laboratory toxicity test results and the chemical/physical characteristics of sediment for those *Leptocheirus plumulosus* and *Neanthes arenaceodentata* test endpoints in which an overall significant negative result was measured

Estuarine wetland avian invertivores:

- Comparison of lead and mercury dietary intakes using field-collected fiddler crab tissue to ingestion-based TRVs

West Indian manatees:

- Comparison of arsenic, cadmium, copper, lead, mercury, selenium, and zinc dietary intakes using field-collected turtle grass tissue to ingestion-based TRVs

Applicable lines of evidence are discussed in the sections that follow for each receptor group/species selected to represent the assessment endpoints.

5.1 Terrestrial Invertebrate Communities

The lines of evidence considered in the evaluation of terrestrial invertebrates were (1) comparison of antimony, copper, lead, mercury, and zinc concentrations in SWMU 2 soil to invertebrate-based screening values, (2) comparison of SWMU 2 and reference area toxicity test results for SWMU 2 and reference area soil, and (3) evidence of a correlation between *Eisenia fetida* toxicity test results and the chemical/physical characteristics of soil for those endpoints in which an overall significant negative result was measured.

5.1.1 Comparison of Ecological COC Concentrations in Soil to Invertebrate-Based Soil Screening Values

The comparison of antimony, copper, lead, mercury, and zinc concentrations in SWMU 2 soil to invertebrate-based screening values used a data set consisting of analytical results for surface and subsurface soil samples collected during the 1992 SI, 1996 RFI, 2004 additional data collection field investigation, and BERA field investigation. For each ecological COC, risk estimates (i.e., HQ values) were derived by dividing maximum, 95 percent UCL of the mean, and arithmetic mean

concentrations by the invertebrate-based screening values listed in Table 4-23 (78 mg/kg for antimony, 80 mg/kg for copper, 1,700 mg/kg for lead, 0.1 mg/kg for mercury, and 120 mg/kg for zinc).

The comparison of maximum, 95 percent UCL of the mean, and arithmetic mean concentrations to invertebrate-based screening values (see Table 4-23) support a conclusion of minimal risks to terrestrial invertebrates from direct contact exposures to antimony and lead in SWMU 2 soil. Antimony was not detected in any soil sample at a concentration greater than the soil screening value. In the case of lead, the HQ value based on the 95 percent UCL of the mean concentration is less than 1.0 (0.30). In addition, the frequency and magnitude of lead detections above the soil screening value is low (lead was detected in only three of ninety-four (3/94) soil samples at concentrations greater than the soil screening value; maximum HQ = 3.44). The absence of antimony detections above the soil screening value, a 95 percent UCL of mean lead HQ value less than 1.0, and the low frequency and magnitude of lead detections above the soil screening value are lines of evidence supporting a conclusion of minimal risks to terrestrial invertebrate communities from direct contact exposures to these two metals in SWMU 2 soil.

The evaluation performed on the copper, mercury, and zinc analytical data (see Table 4-23) support a conclusion of unacceptable risks to terrestrial invertebrate communities. The magnitude of maximum copper, mercury, and zinc concentrations above soil screening values is high (maximum HQs = 241.25 for copper, 190.00 for mercury, and 105.83 for zinc). HQ values for each chemical derived using 95 percent UCL of the mean concentrations also exceed 1.0 (HQs = 19.33 for copper, 15.13 for mercury, and 13.05 for zinc). Finally, the frequency of copper, mercury, and zinc detections above soil screening values is high, ranging from sixty-one of ninety-four (61/94) soil samples for mercury to seventy of ninety-four (70/94) soil samples for copper.

5.1.2 Comparison of Site and Reference Area Earthworm Toxicity Test Results

Direct toxicity to terrestrial invertebrates was evaluated using 28-day *Eisenia fetida* survival, growth, and reproduction tests. Test endpoints for *Eisenia fetida* were survival, calculated as the percentage of test organisms at test initiation that survived in each replicate at test termination; growth, calculated as weight loss per surviving earthworm in each replicate at test termination, and reproduction, expressed as the number of juveniles and cocoons per surviving earthworm in each replicate at test termination.

The statistical evaluations performed by the testing laboratory (discussed in Sections 4.2.2.1) indicated that median survival in SWMU 2 soil samples 2B-SS04-01 and 2B-SS34 (0.00 percent) was significantly lower than median survival in Upland Reference Area No. 2 surface soil samples 2B-REF-SB01, 2B-REF-SS04, and 2B-REF-SS05 (100 percent), while mean weight loss in 2B-SS31 and 2B-SS49 (0.1773 grams and 0.1576 grams, respectively) was significantly greater than mean weight loss in Reference Area No. 2 soil samples 2B-REF-SB01-01 (0.1238 grams) and/or 2B-REF-SS05 (0.0993 grams). Statistical evaluations performed on the reproduction data (number of juveniles and cocoons per surviving earthworm in each replicate at test termination) indicated that reproduction in SWMU 2 soil was not significantly lower relative to reproduction in the reference area soil samples. Although the statistical evaluations did not detect a significant difference in reproduction in any of the SWMU 2 soil samples relative to reproduction in the reference area soil samples, no reproduction occurred in six SWMU 2 soil samples statistically evaluated (2B-SS04, 2B-SS05, 2B-SS10, 2B-SS14, 2B-SS33, and 2B-SS49). Because reproduction also was not evident in each of the reference area soil samples, it cannot be concluded that the lack of reproduction in 2B-SS04, 2B-SS05, 2B-SS10, 2B-SS14, 2B-SS33, and 2B-SS49 represents an adverse site-related effect by one or more of the ecological COCs.

As evidenced by the analytical and toxicity test data presented in Table 4-24, a clear dose-response relationship between ecological COC concentrations and earthworm survival and weight loss was not established by the toxicity tests. Because a clear-dose response relationship could not be established for any of the ecological COCs, it was concluded that physical and/or chemical parameters other than the ecological COC concentrations may have been responsible for or influenced the observed biological responses.

5.1.3 Evidence of a Significant Correlation between Earthworm Toxicity Test Results and the Chemical/Physical Characteristics of Soil

Pair-wise linear regressions were run to statistically examine the relationship between earthworm survival and earthworm weight loss and the chemical/physical characteristics of soil submitted for toxicity testing (twelve SWMU 2 and three reference area soil samples). The following variables were included in the analyses: antimony, copper, lead, mercury, zinc, TOC (results reported by the analytical laboratory), test soil pH (measurements performed by the toxicity testing laboratory at test initiation and test termination), and grain size characteristics (percent gravel, sand, and fines [silt and clay]). As evidenced by Appendix H and Table 4-25, copper, lead, mercury, zinc, TOC, pH at test initiation, pH at test termination, percent gravel, percent sand, and percent fines had no influence on earthworm survival or weight loss. Antimony had a significant influence on earthworm survival. Specifically, earthworm survival decreased as antimony concentrations increased.

To further evaluate the potential relationship between TOC, pH, grain size and ecological COC concentrations in soil and earthworm responses in the toxicity tests (survival and weight loss), a multiple regression analysis was performed using NCSS software. Prior to the analysis, the All Possible Regression variable selection routine was run to identify appropriate models to include within the multiple regression analysis. A five independent variable model was selected for the survival endpoint (antimony, soil pH at test initiation, percent gravel, percent sand, and percent fines). A five independent variable model also was selected for the growth endpoint (copper, lead, mercury, TOC, and percent gravel). Multiple regression analysis indicated that both models are significant. Independent variables within each model also were found to have a significant influence on survival (antimony, percent gravel, percent sand, and percent fines) and growth (copper and percent gravel). The lack of a dose-response in the data paired with the significant multiple regression results suggests that the bioavailability and toxicity of ecological COCs are being influenced by physical properties of the soil (grain size characteristics). However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured soil trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in soil and earthworm responses in the toxicity tests. Therefore, the toxicity tests results could not be used to establish site-specific NOAELs for terrestrial invertebrate direct contact exposures to ecological COCs in SWMU 2 soil.

5.2 Terrestrial Avian Omnivore Populations

A single line of evidence was used to evaluate potential risks to terrestrial avian omnivores from dietary exposures to copper, lead, mercury, and zinc in SWMU 2 soil. Although antimony was not identified as an ecological COC for terrestrial avian omnivore food web exposures in Step 3a of the ERA process (Baker, 2006a and 2007), dietary intakes also were estimated for this metal using earthworm tissue concentrations since the maximum soil concentration for antimony was detected in soil collected during the BERA field investigation. The American robin was used as a representative species for terrestrial avian omnivores at SWMU 2, including the yellow-shouldered blackbird (federally endangered in Puerto Rico). Dietary intakes were estimated using 95 percent UCL of the mean soil and earthworm tissue concentrations. The evaluation showed that dietary intakes for

copper, lead, and mercury exceed NOAEL-based screening values (HQ = 2.74 for copper, 2.10 for lead, and 2.10 for mercury), while dietary intakes for antimony and zinc are less than NOAEL-based screening values (HQ = <0.01 for antimony and 0.26 for zinc). NOAEL-based HQ values based on 95 percent UCL of the mean concentrations indicate that copper, lead, and mercury are bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations feeding exclusively on terrestrial invertebrates at SWMU 2.

To determine if potential risks presented by copper, lead, and mercury are site-related, risk estimates for these three metals were derived for American robin dietary exposures at Upland Reference Area No. 2. Risk estimates for each location (reference area and SWMU 2) were derived using maximum soil and earthworm tissue concentrations. Maximum soil and earthworm tissue concentrations were used since 95 percent UCL of the mean concentrations could not be calculated for the reference area (insufficient number of samples; see Section 4.2.3.2). The maximum NOAEL-based HQ values derived for American robin dietary exposures to copper, lead, and zinc in Upland Reference Area No. 2 soil (HQs = 0.39 for copper, 0.21 for lead, and 0.23 for mercury) show that potential risks presented by these three metals in SWMU 2 soil are site-related.

5.3 Estuarine Wetland Benthic Invertebrate Communities

The lines of evidence considered in the evaluation of estuarine wetland benthic invertebrates were (1) comparison of copper, lead, mercury, and zinc concentrations in SWMU 2 estuarine wetland sediment to literature-based sediment screening values, (2) comparison of SEM sediment concentrations to AVS sediment concentrations, (3) comparison of SWMU 2 and reference area amphipod and polychaete toxicity test results, and (4) evidence of a significant correlation between amphipod and polychaete toxicity test results and the chemical/physical characteristics of sediment for those endpoints in which a overall significant negative result was measured.

5.3.1 Comparison of Ecological COC Concentrations in Sediment to Sediment Screening Values

The comparison of copper, lead, mercury, and zinc concentrations in SWMU 2 estuarine wetland sediment to sediment screening values (see Table 4-32) used a data set consisting of analytical results for sediment samples collected during the 2003 additional data collection investigation, 2004 additional data collection field investigation, and BERA field investigation. For each ecological COC, risk estimates (i.e., HQ values) were derived by dividing maximum, 95 percent UCL of the mean, and arithmetic mean concentrations by the sediment screening values identified in Section 2.5.4 (18.7 mg/kg for copper, 30.2 mg/kg for lead, 0.13 mg/kg for mercury, and 124 mg/kg for zinc).

In the case of zinc, the low magnitude of the maximum detected concentration above the sediment screening value (maximum HQ = 3.39) and the HQ value based on the 95 percent UCL of the mean sediment concentration (HQ = 0.89) support a conclusion of minimal risk to benthic invertebrate communities from this metal in SWMU 2 estuarine wetland sediment. The evaluation performed on the copper, lead, and mercury analytical data (see Table 4-32) support a conclusion of unacceptable risks to estuarine wetland benthic invertebrate communities. The magnitude of maximum detected concentrations above sediment screening values is high (HQs = 37.97 for copper, 14.90 for lead, and 10.00 for mercury). HQ values based on 95 percent UCL of the mean concentrations also exceed 1.0 (HQ = 7.49 for copper, 3.21 for lead, and 2.02 for mercury). Finally, the frequency of detected concentrations above sediment screening values is high, ranging from twelve of forty (12/40) sediment samples for lead to thirty-six of forty-two (36/42) sediment samples for copper.

5.3.2 Comparison of SEM Sediment Concentrations to AVS Sediment Concentrations

The comparison of SEM molar concentrations to AVS molar concentrations (presented in Section 4.2.5 and summarized in Table 4-35) indicate that benthic invertebrates may be exposed to toxic concentrations of copper, lead, and/or zinc in sediment pore water at one 2004 additional data collection field investigation sampling location (2EWSD12) and four BERA field investigation sampling locations (2B-EWSD09, 2B-EWSD15, 2B-EWSD16, and 2B-EWSD24). SEM-to-AVS ratios calculated at 2EWSD12, (2B-EWSD09, 2B-EWSD15, 2B-EWSD16, and 2B-EWSD24 are 126.20, 161.38, 4.51, 54.88, and 45.59, respectively. Total copper, lead, and zinc concentrations detected in sediment samples collected at these locations also exceed bulk sediment screening values (see Section 4.2.5). As evidenced by Figure 3-8, the spatial distribution of sediment with SEM-to-AVS ratios greater than 1.0 and total copper, lead, and zinc concentrations greater than sediment screening values are restricted to locations within the estuarine wetland system adjacent to upland habitat.

5.3.3 Comparison of SWMU 2 and Reference Area Amphipod and Polychaete Toxicity Test Results

Direct toxicity to benthic invertebrates was evaluated using 28-day *Leptocheirus plumulosus* (amphipod) survival, growth, and reproduction tests and 20-day *Neanthes arenaceodentata* (polychaete) survival and growth tests. Test endpoints for *Leptocheirus plumulosus* were survival, calculated as the percentage of test organisms at test initiation that survived as adults at test termination; growth, calculated as dry weight per surviving adult amphipod at test termination, and reproduction, calculated as juvenile production per surviving adult amphipod at test termination. Test endpoints for *Neanthes arenaceodentata* were survival, calculated as the percentage of test organisms at test initiation that survived at test termination; and growth, calculated as dry weight per surviving polychaete at test termination.

5.3.3.1 Amphipod Toxicity Tests

The statistical evaluations performed by the testing laboratory (discussed in Section 4.2.6.1.1 and summarized within Table 4-36), indicated that median survival in SWMU 2 sediment samples 2B-EWSD09 (0.00 percent), 2B-EWSD12 (2.5 percent), 2B-EWSD15 (0.00 percent), 2B-EWSD18 (0.00 percent), 2B-EWSD20 (7.5 percent), and 2B-EWSD24 (0.00 percent) was significantly lower than median survival in reference area sediment samples EW-REF-EWSD01 (95.00 percent) and 2B-REF-EWSD02 (97.50 percent). Median survival in 2B-EWSD04 (20.00 percent) and 2B-EWSD16 (10.00 percent), while not significantly lower when statistically tested at α of 0.05, also was reduced relative to median survival in both reference sediments. Mean dry weight per surviving amphipod in SWMU 2 sediment samples 2B-EWSD04 (0.0536 grams), 2B-EWSD16 (0.0708 grams), and 2B-EWSD20 (0.0417) also was significantly lower than mean dry weight per surviving amphipod in reference area sediment samples EW-REF-EWSD01 (0.1047 grams) and 2B-REF-EWSD02 (0.1280 grams). It is noted that the statistical evaluations performed on the growth data were impaired by low amphipod survival or absence of amphipod survival in sediment samples 2B-EWSD09, 2B-EWSD12, 2B-EWSD15, 2B-EWSD18, and 2B-EWSD24. Therefore, the statistical evaluation of growth data was limited to three SWMU 2 sediment samples (2B-EWSD04, 2B-EWSD16, and 2B-EWSD20).

The statistical evaluations performed by the testing laboratory did not identify any significant differences in reproduction in SWMU 2 samples relative to reference area samples (see Appendix E and Table 4-36). Identical to the statistical evaluations performed on the growth data, statistical evaluations performed on the reproduction data was impaired by low survival. As was previously discussed, there were no surviving amphipods at test termination in 2B-EWSD18 and 2B-EWSD24.

As such, these two sediment samples were excluded from the statistical evaluation of the reproduction data. Although the statistical evaluations did not detect any significant differences in reproduction in SWMU 2 sediment samples relative to reproduction in reference area sediment samples, no reproduction occurred in three of six (3/6) SWMU 2 sediment samples statistically evaluated (2B-EWSD09, 2B-EWSD12, and 2B-EWSD15). The lack of reproduction in these three SWMU 2 sediment samples can be attributed to low survival (2B-EWSD09 had only one surviving amphipod at test termination, while 2B-EWSD12 and 2B-EWSD15 only had four surviving amphipods at test termination).

As evidenced by the analytical and toxicity test data presented in Table 4-36, a clear dose-response relationship between ecological COC concentrations and polychaete survival and growth was not established by the toxicity tests. Because a clear-dose response relationship could not be established for any of the ecological COCs, it was concluded that physical and/or chemical parameters other than ecological COC concentrations may have been responsible for or influenced the observed biological responses.

5.3.3.2 Polychaete Toxicity Tests

The statistical evaluations performed by the testing laboratory (discussed in Section 4.2.6.2.1 and summarized within Table 4-38), indicated that median survival in SWMU 2 sediment sample 2B-EWSD09 (26.25 percent) was significantly lower than mean survival in reference area sediment samples 2B-REF-EWSD01 (73.75 percent). Polychaete growth (i.e., dry weight per surviving amphipod) was not significantly lower in any SWMU 2 sediment sample relative to polychaete growth in reference area sediment samples (see Appendix E and Table 4-38).

As evidenced by the analytical and toxicity test data presented in Table 4-38, a clear dose-response relationship between ecological COC concentrations and amphipod survival and growth was not established by the toxicity tests. Because a clear-dose response relationship could not be established for any of the ecological COCs, it was concluded that physical and/or chemical parameters other than ecological COC concentrations may have been responsible for or influenced the observed biological responses.

5.3.4 **Evidence of a Significant Correlation between Amphipod and Polychaete Toxicity Test Results and the Chemical/Physical Characteristics of Sediment**

Pair-wise linear regressions and multiple regressions were run to statistically examine the relationship between amphipod survival and growth and polychaete survival and the chemical/physical characteristics of sediment submitted for toxicity testing.

5.3.4.1 Amphipod Toxicity Tests

Pair-wise linear regressions were run to statistically examine the relationship between *Leptocheirus plumulosus* survival and growth and the chemical physical characteristics of sediment submitted for toxicity testing (eight SWMU 2 and two reference area sediment samples). The following sediment variables were included in the analysis: copper, lead, mercury, zinc, SEM-to-AVS ratios, total ammonia, sulfide, pH, TOC, and grain size characteristics [percent gravel, sand, and fines]. In addition to these sediment variables, the linear regression analysis included the following overlying water and pore water parameters: pH, salinity, and total ammonia. As evidenced by Appendix K and Table 4-37, the linear regression analysis indicated that the ecological COCs (copper, lead, and zinc) did not have a significant influence on amphipod survival or growth. The following sediment and pore water variables also had no influence on amphipod survival or growth: sediment mercury, SEM-

to-AVS ratios, total ammonia, sulfide, TOC, and grain size characteristics (percent gravel, sand, and fines); pore water salinity, total ammonia, and pH. However, sediment pH and overlying water salinity, total ammonia, and pH had a significant influence on amphipod survival, while sediment pH and overlying water total ammonia and pH had a significant influence of amphipod growth. The linear regression reports for these variables showed the following relationships:

- Amphipod survival and growth decreased as sediment pH increased
- Amphipod survival and growth decreased as overlying water pH increased
- Amphipod survival and growth increased as overlying water total ammonia increased
- Amphipod survival increased as overlying water salinity increased.

To further evaluate the relationship between copper, lead, mercury, and zinc concentrations in sediment, sediment pH, overlying water pH, salinity, and total ammonia, and amphipod survival in the toxicity tests, a multiple regression analysis was performed using NCSS software. Prior to the analysis, the All Possible Regression variable selection routine was run to identify appropriate models to include within the multiple regression analyses. A three independent variable model was selected for the survival endpoint (copper, lead, and sediment pH). Results of the multiple regression analysis indicated that the three independent variable model for survival was significant. Within the model, copper and sediment pH had a significant influence on amphipod survival. Taking into consideration the results of the linear regressions, which demonstrated that amphipod survival decreased with increasing pH, and the results of the multiple regression, which demonstrated that copper and pH have a significant influence on amphipod survival, it can be concluded that the bioavailability and toxicity of copper is being influenced by sediment pH. However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured sediment trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in sediment and amphipod survival in the toxicity tests.

The All Possible Regression variable selection routine and multiple regression analysis were not performed for the amphipod growth and reproduction endpoints for the reasons discussed in Section 4.2.6.1.2.

5.3.4.2 Polychaete Toxicity Tests

Pair-wise linear regressions were run to statistically examine the relationship between *Neanthes arenaceodentata* survival and the chemical physical characteristics of sediment submitted for toxicity testing (eight SWMU 2 and two reference area sediment samples). The following sediment variables were included in the analysis: copper, lead, mercury, zinc, SEM-to-AVS ratios, total ammonia, sulfide, pH, TOC, and grain size characteristics (percent gravel, sand, and fines). In addition to these sediment variables, the linear regression analysis included the following overlying water and/or pore water parameters: pH, salinity, total ammonia, and sulfide. As evidenced by Appendix L and Table 4-39, the linear regression analysis indicated that the ecological COCs (copper, lead, and zinc) did not have a significant influence on polychaete survival. The following sediment, overlying water, and pore water variables also had no influence on polychaete survival: sediment mercury, total ammonia, sulfide, TOC, percent gravel, and percent fines; overlying water salinity, total ammonia, and pH; pore water salinity, sulfide, total ammonia, and pH. However, SEM-to-AVS ratios and the percent sand

content of sediment had a significant influence on polychaete survival. The regression reports for these two variables show the following relationships:

- Polychaete survival decreased as the SEM-to-AVS ratio increased
- Polychaete survival decreased as the percent sand content of sediment increased

To further evaluate the relationship between copper, lead, mercury, zinc, and AVS concentrations in sediment, the percent sand content of sediment, and polychaete survival in the toxicity tests, a multiple regression analysis was performed using NCSS software. Prior to the analysis, the All Possible Regression variable selection routine was run to identify appropriate models to include within the multiple regression analyses. A four independent variable model was selected for the survival endpoint (copper, lead, SEM-to-AVS ratio, and percent sand). Results of the multiple regression analysis indicated that the four independent variable model for survival was significant. Within the model, SEM-to-AVS ratio had a significant influence on polychaete survival. Taking into consideration the results of the linear regressions, which demonstrated that polychaete survival decreased with increasing SEM-to-AVS ratios, and the results of the multiple regression, which demonstrated that the SEM-to-AVS ratio of sediment had a significant influence on polychaete survival, it can be concluded that the bioavailability and toxicity of copper and lead is being influenced by sediment AVS concentrations. However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured sediment trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in sediment and polychaete survival in the toxicity tests.

5.4 Estuarine Wetland Avian Invertivore Populations

A single line of evidence was used to evaluate potential risks to avian invertivore populations from dietary exposures to lead and mercury in SWMU 2 estuarine wetland sediment. The spotted sandpiper was used as a representative species for wading birds at SWMU 2. Dietary intakes were estimated using 95 percent UCL of the mean sediment and fiddler crab tissue concentrations. The evaluation showed that dietary intakes for lead exceed NOAEL-, MATC-, and LOAEL-based values (HQs = 3.68, 2.60, and 1.84, respectively; see Table 4-42). Because lead HQ values for each ingestion-based TRV (NOAEL-, MATC-, and LOAEL-based TRVs) exceed 1.0, it was concluded that lead is bioaccumulating within invertebrate tissue at concentrations that could impact aquatic avian invertivore populations that feed exclusively on invertebrates within the estuarine wetland habitat at SWMU 2. Identical to lead, dietary intakes for mercury exceed the NOAEL-based TRV (HQ = 1.45). However, MATC- and LOAEL-based HQ values for this metal are less than 1.0 (0.84 and 0.48, respectively). Given that NOAEL values are, in part, artifacts of dose selection and do not represent actual threshold effects, greater weight is given to HQ values based on MATC values. Therefore, it was concluded that mercury is not bioaccumulating within invertebrate tissue at concentrations that would impact aquatic avian invertivore populations feeding exclusively on terrestrial invertebrates at SWMU 2.

To determine if potential risks presented by lead are site-related, risk estimates for this metal were derived for spotted sandpiper dietary exposures at the estuarine wetland reference area. NOAEL-, MATC-, and LOAEL-based risk estimates, derived using maximum sediment and fiddler crab tissue concentrations, were less than 1.0 (0.31, 0.22, and 0.15, respectively), indicating that the potential risk presented by lead in SWMU 2 estuarine wetland sediment is site-related.

5.5 West Indian Manatees

Identical to the evaluation of terrestrial avian omnivores, a single line of evidence was used to evaluate potential risks to West Indian manatees that may forage within the open water portion of SWMU 2: comparison of estimated arsenic, cadmium, copper, lead, mercury, selenium, and zinc dietary intakes using turtle grass tissue analytical data to NOAEL-based screening values. The evaluation, which used maximum arsenic, cadmium, lead, mercury, and selenium concentrations in SWMU 2 turtle grass tissue and sediment, showed that dietary intakes for each ecological COPC are less than NOAEL-based screening values (i.e., HQ = 0.65 for arsenic, 0.12 for cadmium, 0.20 for copper, 0.09 for lead, 0.64 for mercury, 0.79 for selenium, and 0.63 for zinc). The HQ values indicate that these seven metals are not bioaccumulating in turtle grass at concentrations that would impact West Indian manatees that feed exclusively within the open water portion of SWMU 2.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions from the evaluation of the analytical and toxicity test data, as well as recommendations for the SWMU are presented below. The decision rules and criteria that were used to outline potential recommendations and actions associated with the lines of evidence discussed in Section 5.0 are presented in Table 2-16.

6.1 Conclusions

An overview of the BERA results for the lines of evidence used to assess each receptor/receptor group evaluations, as well as conclusions of the evaluation are presented within the sections that follow.

6.1.1 Terrestrial Invertebrate Communities

The comparison of antimony, copper, lead, mercury, and zinc concentrations in SWMU 2 surface and subsurface soil to soil screening values indicated that antimony and lead present minimal risks to terrestrial invertebrate communities. HQ values based on 95 percent UCL of the mean concentrations are less than 1.0 (0.08 for antimony and 0.30 for lead). However, HQ values for copper, mercury, and zinc indicate that these three metals may be impacting terrestrial invertebrate communities at SWMU 2 (HQ values based on 95 percent UCL of the mean concentrations are 19.33, 15.13, and 13.05, respectively).

Soil toxicity tests were run using *Eisenia fetida* to further refine potential risks suggested by the comparison of ecological COC concentrations to soil screening values. Toxicity tests can account for effects of multiple chemicals (i.e., additive, synergistic, and antagonistic effects), as well as site-specific factors that may influence the bioavailability of metals (e.g., pH, TOC, and grain size characteristics). The statistical evaluations performed by the testing laboratory indicated that earthworm reproduction (juvenile and cocoon production per surviving earthworm) in SWMU 2 soil was not significantly lower than reproduction in each reference area soil. However, a significant response was detected by the statistical tests evaluating earthworm survival and growth. Earthworm survival in SWMU 2 soil samples 2B-SS04-01 and 2B-SS34 was significantly lower relative to earthworm survival in Upland Reference Area No. 2 soil samples 2B-REF-SB01-01, 2B-REF-SS04, and 2B-REF-SS05, while earthworm weight loss in SWMU 2 soil samples 2B-SS31 and 2B-SS49 was significantly greater than earthworm weight loss in Upland Reference Area No. 2 soil sample 2B-REF-SS05. Earthworm weight loss in SWMU 2 soil sample 2B-SS31 also was greater than earthworm weight loss in Upland Reference Area No. 2 soil sample 2B-REF-SS01-01.

Pair-wise linear regressions and multiple regressions were performed to further examine the relationship between earthworm survival and weight loss and the chemical/physical characteristics of SWMU 2 surface soil. The pair-wise linear regressions indicated that no soil variable had a significant influence of earthworm weight loss. However, antimony concentrations in soil were found to have a significant influence on earthworm survival. Multiple regressions also indicate that antimony, as well as grain size characteristics (percent gravel, and, and fines [silt and clay]), are influencing earthworm survival, while copper and percent gravel are influencing earthworm weight loss. The lack of a dose-response relationship in the data paired with the significant multiple regression results suggest that the bioavailability and toxicity of ecological COCs are being influenced by physical characteristics of the soil (i.e., grain size characteristics). However, this modifying factor, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured soil trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in soil and earthworm responses

in the toxicity tests. Therefore, the toxicity test results could not be used to establish site-specific NOAELs for terrestrial invertebrate direct contact exposures to ecological COCs in SWMU 2 soil.

The three lines of evidence used to evaluate terrestrial invertebrate direct contact exposures to ecological COCs in SWMU 2 soil support a conclusion of unacceptable risk. However, clear relationships between ecological COC concentrations in soil and earthworm responses in toxicity tests could not be established.

6.1.2 Terrestrial Avian Omnivore Populations

American robin dietary intakes for antimony and zinc, derived using 95 percent UCL of the mean earthworm tissue and soil concentrations, are less than NOAEL-based screening values (HQ = <0.01 for antimony and 0.26 for zinc). However, dietary intakes for copper, lead, and mercury exceed NOAEL-based screening values (HQ = 2.74 for copper, 2.10 for lead, and 2.10 for mercury), indicating that these three metals are bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivore populations feeding exclusively on terrestrial invertebrates at SWMU 2. To determine if potential risks presented by copper, lead, and mercury are site-related, risk estimates for these three metals were derived for American robin dietary exposures at Upland Reference Area No. 2. Based on the low number of soil samples collected at the upland reference area during the BERA field investigation (six soil samples) and the low number of upland reference area earthworm tissue samples submitted for analytical testing (three earthworm tissue samples), risk estimates were derived using maximum concentrations. The NOAEL-based HQ values derived for the upland reference area (HQ = 0.39 for copper, 0.21 for lead, and 0.23 for mercury) clearly show that risks presented by copper, lead, and mercury at SWMU 2 are site-related. The single line of evidence used to evaluate terrestrial avian omnivores supports a conclusion of unacceptable risk from dietary exposures to copper, lead, and zinc in SWMU 2 soil.

6.1.3 Estuarine Wetland Benthic Invertebrate Communities

The comparison of copper, lead, mercury, and zinc concentrations in SWMU 2 estuarine wetland sediment to sediment screening values indicated that zinc presents minimal risks to benthic invertebrate communities. The HQ value based on the 95 percent UCL of the mean concentration is less than 1.0 (HQ = 0.89). However, 95 percent UCL of the mean HQ values for copper, lead, and mercury indicate that these three metals may be impacting benthic invertebrate communities at SWMU 2 (HQ = 7.49 for copper, 3.21 for lead, and 2.02 for mercury). The comparison of SEM molar concentrations to AVS molar concentrations indicated that benthic invertebrates may be exposed to toxic concentrations of copper, lead, and/or zinc in sediment pore water at the 2B-EWSD09, 2B-EWSD15, 2B-EWSD16, and 2B-EWSD24 sampling locations.

Sediment toxicity tests were run using 28-day *Leptocheirus plumulosus* survival, growth and reproduction tests and *Neanthes arenaceodentata* survival and growth tests to further refine potential risks suggested by the comparison of ecological COC concentrations to sediment screening values and SEM molar concentrations to AVS molar concentrations. As discussed in Section 6.1.1 above, toxicity tests can account for effects of multiple chemicals (i.e., additive, synergistic, and antagonistic effects), as well as site-specific factors that may influence the bioavailability of metals (e.g., pH, TOC, AVS, and grain size characteristics). The statistical evaluations performed by the testing laboratory indicated that amphipod survival in six of the eight SWMU 2 sediment samples tested for toxicity (2B-EWSD09, 2B-EWSD12, 2B-EWSD15, 2B-EWSD18, 2B-EWSD20, and 2B-EWSD24) relative to survival in the reference sediments (2B-REF-EWSD01 and 2B-REF-EWSD02). A significant decrease in amphipod growth also was detected in SWMU 2 sediment samples 2B-EWSD04, 2B-EWSD16, and 2B-EWSD20 relative to growth in reference sediment samples (2B-

REF-EWSD-01 and 2B-EWSD-02). In the case of polychaetes, survival in SWMU 2 sediment sample 2B-EWSD09 was significantly lower than survival in reference sediment sample 2B-REF-EWSD01. Statistical evaluations did not detect a significant decrease in amphipod reproduction or polychaete growth in SWMU 2 sediment.

Pair-wise linear regressions and/or multiple regressions were performed to further examine the relationship between amphipod survival and growth and polychaete survival and the chemical/physical characteristics of SWMU 2 estuarine wetland sediment, sediment pore water, and overlying toxicity test water. For amphipods, the pair-wise linear regressions indicated sediment pH and overlying water pH, total ammonia, and salinity have a significant influence on amphipod survival. Sediment pH and overlying water pH and total ammonia also have a significant influence on amphipod growth. Multiple regressions indicated that sediment pH, as well as copper are influencing amphipod survival. For the reasons discussed in Section 4.2.6.1.2, a multiple regression analysis was not performed for the amphipod growth endpoint. In the case of the polychaete tests, pair wise linear regressions showed that SEM-to-AVS ratios and percent sand had a significant influence on polychaete survival. Multiple regressions also indicated that sediment SEM-to-AVS ratios have a significant influence on polychaete survival. The lack of a dose-response relationship in the data paired with the significant multiple regression results suggest that the bioavailability and toxicity of ecological COCs are being influenced by sediment pH and AVS. However, these modifying factors, as well as other factors such as additive, synergistic, or antagonistic effects of co-located ecological COCs or the presence of an unmeasured sediment trait, prevent the establishment of a clear relationship between individual ecological COC concentrations in sediment and organisms responses in the toxicity tests. Therefore, the toxicity test results could not be used to establish site-specific NOAELs for benthic invertebrate direct contact exposures to ecological COCs in SWMU 2 estuarine wetland sediment.

The four lines of evidence used to evaluate benthic invertebrate direct contact exposures to ecological COCs in SWMU 2 estuarine wetland sediment support a conclusion of unacceptable risk. However, clear relationships between ecological COC concentrations in sediment and organism responses in toxicity tests could not be established.

6.1.4 Estuarine Wetland Avian Invertivore Populations

The modeled spotted sandpiper dietary intake for mercury, derived using 95 percent UCL of the mean fiddler crab tissue and sediment concentrations, is less than the MATC-based screening value (HQ = 0.84). However, the modeled dietary intake for lead exceeds the MATC-based screening value (HQ = 2.60), indicating that this metal is bioaccumulating in fiddler crab tissue at concentrations that could impact estuarine wetland invertivore populations feeding exclusively on benthic invertebrates at SWMU 2. To determine if potential risks presented by lead are site-related, risk estimates were derived for spotted sandpiper dietary exposures at the estuarine wetland area. Based on the low number of sediment samples collected at the estuarine wetland area during the BERA field investigation (six sediment samples) and the low number of estuarine wetland reference area fiddler crab tissue samples submitted for analytical testing (four fiddler crab tissue samples), risk estimated were derived using maximum concentrations. The NOAEL- MATC-, and LOAEL-based HQ values derived for the estuarine wetland reference area (HQs = 0.31, 0.22, and 0.15, respectively) clearly show that risks presented by lead at SWMU 2 are site-related. The single line of evidence used to evaluate terrestrial avian omnivores supports a conclusion of unacceptable risk from dietary exposures to lead in SWMU 2 estuarine wetland sediment.

6.1.5 West Indian Manatees

West Indian manatee dietary intakes for arsenic, cadmium, copper, lead, mercury, selenium, and zinc, derived using maximum measured turtle grass tissue and sediment concentrations, are less than NOAEL-based screening values (HQ = 0.65 for arsenic, 0.12 for cadmium, 0.20 for copper, 0.09 for lead, 0.64 for mercury, 0.79 for selenium, and 0.63 for zinc). The HQ values indicate that these seven metals are not bioaccumulating in turtle grass tissue at concentrations that would impact West Indian manatees feeding exclusively within the open water portion of SWMU 2.

6.2 Recommendations

The lines of evidence for terrestrial invertebrates, terrestrial avian omnivores, estuarine wetland benthic invertebrates, and estuarine wetland avian invertivores, when evaluated using a weight-of-evidence approach and taking into consideration the uncertainty associated with them (see Section 7.0), support additional evaluation. Initially, it is recommended that an Interim Corrective Measure (ICM) be performed (i.e., soil removal) to eliminate potential risks to terrestrial avian omnivores from exposures to copper, lead, and mercury in soil (surface and subsurface soil). The ICM also will serve to reduce potential risks presented by antimony, copper, lead, mercury, and zinc to terrestrial invertebrates based on their co-location with one another. Finally, the ICM will serve to eliminate/reduce potential source areas in upland habitat serving as a release point for chemical migration to the estuarine wetland. Specifics of the soil removal action, including locations and volumes, will be detailed within the ICM's Basis of Design Report. Following the ICM, it is recommended that SWMU 2 proceed to a CMS to further address low-level, wide-spread spatial coverage of ecological COCs above soil and background soil screening values, as well as unacceptable risks presented by copper, lead, mercury, and zinc to estuarine wetland benthic invertebrates and/or avian invertivores. Based on the evaluation of West Indian manatee dietary exposures using measured ecological COC concentrations in turtle grass tissue and sediment, a recommendation of corrective action complete without controls is made for sediments within the Ensenada Honda.

7.0 UNCERTAINTIES

Uncertainties are present in all risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. The BERA was designed to reduce the uncertainties identified from previous investigations, to address suspected confounding influences, and to provide a more realistic evaluation of potential risks in the terrestrial, estuarine, and open water habitats at SWMU 2. Uncertainties that have been identified for the BERA are presented and discussed below to aid in risk management decisions about the site.

Analytical Data

- Analytical data for several chemicals were qualified as estimated, “J” because the results fall between the method detection limit (MDL) and method reporting limit (MRL). Although concentrations that fall between the MDL and MRL are considered usable, they are estimated values with greater uncertainty. Analytical data for several chemicals also were qualified as estimated, “J” and estimated, “UJ” due to a number of issues identified during data validation activities (see Appendix F). Identical to the “J” flagged analytical data, these data are usable with the understanding that the associated values are estimated.
- Soil and sediment samples submitted for toxicity testing were analyzed for particle size (i.e., grain size) by the analytical laboratory using a modified version of ASTM Method D-422 (sieve only). Because sedimentation using a hydrometer was not performed as part of the test method, particles with diameters less than 75 µm were classified as “fines” (percent silt and percent clay were not measured). Clay is a soil and sediment characteristic that has been shown to influence the bioavailability of metals to microorganisms, plants, and invertebrates (bioavailability decreases with increasing clay content). Because the modified analytical method cannot classify particles with diameters less than 75 µm, pair-wise linear regressions examining the relationship between earthworm survival and weight loss and the clay content of soil or the relationship between amphipod and polychaete survival and the clay content of sediment could not be performed.
- A third uncertainty related to the analytical data applies to the quick-turn analytical results used to select soil samples for toxicity testing. The SWMU 2 soil samples submitted for toxicity testing were selected from a pool of fifty samples submitted to the analytical laboratory for quick-turn analytical testing. Because the selection of soil samples for toxicity testing used unvalidated analytical results, QA/QC issues associated with the analytical data were not taken into consideration. Quick-turn antimony concentrations reported in SWMU 2 soil samples 2B-SS46 through 2B-SS50 and, with the exception of 2B-REF-SS04, each Upland Reference Area No. 2 soil sample, as well as the quick-turn mercury concentration reported in reference area subsurface soil samples 2B-REF-SB01-01, 2B-REF-SB04-01, and 2B-REF-SB05-01, were qualified as non-detect, “U” at the reporting limit due to contamination in associated continuing calibration blanks and/or preparation blanks (see validation narrative for SDG SWMU 26880-1 in Appendix F). These minor data qualification actions had no impact on the design of the investigation.

Reference Area Selection

- Upland Reference Area No. 2 was selected as a source of soil for earthworm toxicity testing even though chromium and vanadium were detected in subsurface soil collected during verification of the field sampling design at concentrations greater than soil and background screening values. This decision was based, in part, on the successful use of Upland

Reference Area No. 2 as a source of surface soil for *Eisenia fetida* toxicity testing during a BERA conducted at SWMU 1. Specifically, earthworms exposed to Upland Reference Area No. 2 surface soil during the BERA at SWMU 1 met the minimum requirements specified by ASTM (2006a) for control soil (i.e., 90 percent mean survival in each replicate test chamber at test termination). Upland Reference Area No. 2 surface and subsurface soil tested for toxicity in this BERA investigation also met the minimum requirements for control soil (earthworm survival in each reference area soil sample was 100 percent), thereby reducing the uncertainty of selecting Upland Reference Area No. 2 as a source of reference soil for toxicity testing.

Lines of Evidence

- Maximum lead and mercury concentrations in SWMU 2 soil were detected in samples collected during previous investigations. The maximum lead concentration (5,850J mg/kg) was detected in a subsurface soil sample collected during the 1992 SI (06SS141), while the maximum mercury concentration (19J mg/kg) was detected in a surface soil sample collected during the 2004 additional data collection field investigation (2SS11). Both sample locations (subsurface soil sample 06SS141 was collected at location 06SS101) were re-sampled during the BERA field investigation (see Section 3.2.1). However, these maximum concentrations were not duplicated or exceeded (maximum lead and mercury concentrations detected and tested for toxicity were 3,550J mg/kg and 8.7J mg/kg, respectively). Because maximum concentrations were not duplicated or exceeded during the BERA field investigation, earthworms were not exposed to maximum lead and mercury concentrations during toxicity testing. Furthermore, earthworm tissue concentrations used in the estimation of avian omnivore dietary exposures do not reflect bioaccumulation under conditions of maximum exposures. While this issue may be explained by the variability in analytical method, it is important to note that the range of range of concentrations evaluated in the BERA were sufficient to demonstrate an effect.

Although the BERA field investigation did not assess the maximum lead concentration, the evaluation presented in Section 4.2.3.2 showed that exposure to lower soil concentrations still resulted in bioaccumulation within at concentrations that could impact terrestrial avian omnivores that feed exclusively on terrestrial invertebrates at SWMU 2. Based on this result, the maximum lead concentration detected during the 2004 additional data collection field investigation will be addressed by the soil removal action recommended in Section 6.2. In the case of mercury, because earthworms were not exposed to the maximum concentration during toxicity testing, the tissue concentration used to estimate dietary exposures may have resulted in an understatement of potential risks to terrestrial avian omnivores. It is noted that BERA soil samples collected at and within the 20-foot by 20-foot sampling grid established around 2004 additional data collection field investigation 2SS11 (2B-SS11 through 2B-SS15) contained elevated concentrations of lead. For example, lead was detected in soil samples 2B-SS11 and 2B-SS14 at 418 mg/kg and 795 mg/kg, respectively. As discussed above, the evaluation presented in Section 4.2.3.2 showed that lead is bioaccumulating in earthworm tissue at concentrations that could impact terrestrial avian omnivores. Therefore, the soil removal action recommended in Section 6.2 also will indirectly address any potential mercury impacts to terrestrial avian omnivore populations.

- A second uncertainty related to the lines of evidence employed in the BERA applies to antimony in SWMU 2 soil. As discussed in Section 4.2.1.1, antimony was not detected in SWMU 2 soil at concentrations greater than the soil screening value. However, pair-wise linear regressions and the multiple regression analysis presented in Section 4.2.2.3 indicated

that antimony, in part, may be responsible for the observed decrease in earthworm survival during the toxicity tests. Further evaluation of the scatter plot included as part of the antimony linear regression report in Appendix H did not suggest that antimony concentrations are influencing earthworm survival. The discrepancy between these lines of evidence may reflect the impact that co-location of ecological COCs, interactions between ecological COCs (i.e., additive, synergistic, or antagonistic effects), and/or soil properties (e.g., TOC, pH, and grain size characteristics) have on the toxicity of SWMU 2 soil to earthworms.

- A third uncertainty related to the lines of evidence employed in this BERA applies to the earthworm, amphipod, and polychaete toxicity tests. As stated elsewhere in this document, a clear relationship between individual ecological COC concentrations in soil and sediment and organism responses in the toxicity tests could not be established. The lack of a dose response in the toxicity test data paired with the significant pair-wise and multiple regression results suggest that the bioavailability and toxicity of ecological COCs in soil are being influenced by the grain size characteristics of soil, while the bioavailability and toxicity of ecological COCs in sediment are being influenced by sediment pH and AVS concentrations. The inability to establish site-specific NOAEL values using toxicity tests and the apparent influence grain size has on the bioavailability and toxicity of ecological COCs in soil and the apparent influence sediment pH and AVS concentrations have on the bioavailability and toxicity of ecological COCs in sediment requires that a greater reliance be put on the comparison of ecological COC concentrations to soil and sediment screening values when making recommendations for the SWMU.
- A fourth uncertainty related to the lines of evidence employed in the BERA applies to dietary intakes for West Indian manatee exposures to lead in SWMU 2 sediment may understate food web exposures. As discussed in Section 4.2.8.1, lead concentrations detected in sediment samples collected during the BERA field investigation (3.8J mg/kg in 2B-OWSD01, 2.6J mg/kg in 2B-OWSD02, 3.2J mg/kg in 2B-OWSD02D, and 4.2J mg/kg in 2B-OWSD03) are over an order of magnitude less than the maximum concentration detected during the 2003 additional data collection field investigation (48 mg/kg in 02OWSD04; see Table 2-13). If the only factor influencing lead bioaccumulation in turtle grass tissue is the concentration of lead in sediment, the risk estimate for this metal may understate actual risks to the West Indian manatees. It is noted that the NOAEL-based HQ derived using the maximum detected lead concentration in field collected turtle grass tissue is over an order of magnitude less than 1.0 (i.e., 0.09).

This uncertainty is addressed by the unrealistic assumption that West Indian manatees feed exclusively within the open water portion of SWMU 2. Use of an AUF of 1.0 is an extremely conservative assumption since a significant percentage of time could be spent foraging off-site in areas not impacted by site-related chemicals or areas where chemical concentrations are expected to be significantly lower. For example, the Florida population of the West Indian manatee ranges over fairly large areas during the summer (covering up to 200 linear km of river or coastline). Unlike the Florida population, which aggregates within the confines of natural or artificial warm water refuges during winter periods (USFWS, 1996c), there is no evidence of periodicity in manatee behavior in Puerto Rico (USFWS, 1986b). As such, it cannot be expected that West Indian manatees would exclusively forage within the open water portion of SWMU 2.

Ecological Receptors

- The American robin was used as a surrogate receptor for the yellow-shouldered blackbird. The American robin was modeled as a ground-feeding receptor. However, as discussed in Section 2.5.4, the yellow-shouldered black bird is an arboreal feeder that forages within the canopy and sub-canopy of trees (USFWS, 1996a). It is assumed that the American robin can be protectively used as a surrogate receptor for the yellow-shouldered blackbird. However, the diet of the yellow-shouldered blackbird likely includes carnivorous arthropods (i.e., spiders) that may bioaccumulate ecological COCs at higher concentrations than the prey item modeled for the American robin (earthworms). If bioaccumulation in prey items consumed by the yellow-shouldered blackbird exceeds bioaccumulation in the prey item consumed by the American robin (i.e., earthworms), risk estimates derived for the American robin will understate potential risks to the yellow-shouldered blackbird.

Limited data is available regarding the diet preferences of the yellow-shouldered blackbird; however, available information from the literature indicates that spiders represent a minor contribution to the total diet. Wetmore (1916) analyzed the stomach contents of 55 yellow-shouldered blackbirds at eleven undisclosed locations within Puerto Rico. The stomach content data from this investigation (<http://fwie.fw.vt.edu/WWW/esis/lists/e104009.htm>) show that representatives of the order Arachnida contributed only 7.83 percent by weight to the total diet. This compares to a 35.21 percent by weight contribution by Coleoptera (beetles), a 28.32 percent by weight contribution by Lepidoptera (moths and butterflies), a 9.06 percent by weight contribution by Homoptera (e.g., cicadas and aphids), and a 9.90 percent by weight contribution by plant material. Furthermore, given that yellow-shouldered blackbirds are arboreal, it can be concluded that spiders consumed by yellow-shouldered blackbirds also are arboreal and are not likely to bioaccumulate ecological COCs to the extent that forest litter spiders do. Finally, it is noted that the USEPA (2005f) did not consider ecological soil screening level development appropriate for arboreal insectivores (mammals and birds) because they do not forage from terrestrial environments. The stomach content data reported by Wetmore (1916), as well as the exclusion of arboreal avian insectivores from ecological soil screening level development by the USEPA (2005f), supports the assertion that the American robin (modeled as a ground insectivore) can be protectively used as a surrogate receptor for the yellow-shouldered blackbird.

8.0 REFERENCES

- Adams, W.J., R.A. Kimerle, and R.G. Mosher. 1985. p. 429 in Cardwell, R.D., R. Purdy, and R.C. Bahner (eds.). *Aquatic Toxicology and Hazard Assessment: Seventh Symposium*. American Society of Testing and Materials, Philadelphia, PA.
- Adriano, D.C. 2001. *Trace Elements in Terrestrial Environments: Biogeochemistry, Bioavailability and Risks of Metals*. Second Edition. Springer-Verlag, New York. 867 pp.
- Agency for Toxic Substances and Disease Registry. (ATSDR). 2005a. *Toxicological Profile for Arsenic*. PB/2000/108021. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September, 2005.
- ATSDR. 2005b. *Draft Toxicological Profile for Lead*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2005.
- ATSDR. 2005c. *Toxicological Profile for Zinc*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. August 2005
- ATSDR. 2004. *Toxicological Profile for Copper*. PB2004-10733. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2004.
- ATSDR. 2003. *Toxicological Profile for Selenium*. PB2004-100005. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 2003.
- ATSDR. 1999a. *Toxicological Profile for Cadmium*. PB/99/166621. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. July 1999.
- ATSDR. 1999b. *Toxicological Profile for Mercury*. PB/99/142416. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. March 1999.
- ATSDR. 1992. *Toxicological Profile for Antimony and Compounds*. PB/93/110641/AS. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. September 1992.
- Allcroft, R., K.N. Burns, and G. Lewis. 1961. The Effects of High levels of Copper in Rations for Pigs. *Vet. Rec.* 73:714.
- Alva, A.K., B. Huang, and S. Paramasivam. 2000. Soil pH Affects Copper Fractionation and Phytotoxicity. *Soil Sci. Soc. Am. J.* 64:955-962.
- American Society for Testing and Materials (ASTM). 2006a. Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm *Eisenia Fetida* and the Enchytraeid Potworm *Enchytraeus albidus*. In, *Annual Book of ASTM Standards, Volume 11.06*. E 1676-04.
- ASTM. 2006b. Standard Guide for Conducting Acute, Chronic, and Life-Cycle Aquatic Toxicity Tests with Polychaetous Annelids. In, *Annual Book of ASTM Standards, Volume 11.06*. E 1562-94.
- Andreae, M.O. and P.N. Froehlich, Jr. 1984. Arsenic, Antimony, Germanium Biogeochemistry in the Baltic Sea. *Tellus Ser. B.* 36B:101-117.

- Andreae, M.O., J.T. Byrd, and P.N. Froehlich, Jr. 1983. Arsenic, Antimony, Germanium, and Tin in the Tejo Estuary, Portugal: Modeling a Polluted Estuary. *Environ. Sci. Technol.* 17:731-737.
- Ankari, A., H. Najib, and A. Hozab. 1998. Yolk and Serum Cholesterol and Production Traits, as Affected by Incorporating a Supraoptimal Amount of Copper in the Diet of the Leghorn Hen. *Br. Poult. Sci.* 39(3):393-397.
- Ankley, G.T. 1996. Evaluation of Metal/Acid Volatile Sulfide Relationships in the Prediction of Metal Bioaccumulation by Benthic Macroinvertebrates. *Environ. Toxicol. Chem.* 15:2138-2146.
- Long, E.R., D.D. MacDonald, J.C. Cubbage, and C.G. Ingersoll. 1997. Predicting the Toxicity of Sediment-Associated Trace Metals with Simultaneously Extracted Trace Metal:Acid-Volatile Sulfide Concentrations and Dry-Weight Normalized Concentrations: A Critical Comparison. *Environ. Toxicol. Chem.* 17:972-974.
- Ankley, G.T., D.M. Di Toro, D.J. Hansen, and W.J. Berry. 1996. Technical Basis and Proposal for Deriving Sediment Quality Criteria for Metals. *Environ. Toxicol. Chem.* 15:2056-2066.
- Aulerich, R.J., R.K. Ringer, and S. Iwamoto. 1974. Effects of Dietary Mercury on Mink. *Arch. Environ. Contam. Toxicol.* 2:43-51.
- Austin, L.S. and G.E. Millwood. 1988. Simulated Effects of Tropospheric Emissions on the Global Antimony Cycle. *Atmos. Environ.* 22:1395-1403.
- Baker Environmental, Inc. 2009. *Final Steps 6 and 7 of the Baseline Ecological Risk Assessment, SWMU 1, Naval Activity Puerto Rico, Ceiba Puerto Rico*. Coraopolis, Pennsylvania. July 1, 2009.
- Baker. 2008a. *Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. February 29, 2008.
- Baker. 2008b. *Final Steps 6 and 7 of the Baseline Ecological Risk Assessment, SWMU 45, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. July 11, 2008.
- Baker. 2008c. *Draft Steps 6 and 7 of the Baseline Ecological Risk Assessment, SWMU 1, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. July 1, 2009.
- Baker. 2007. *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. January 10, 2007.
- Baker. 2006a. *Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. May 18, 2006.
- Baker. 2006b. *Draft Steps 3b and 4 of the Baseline Ecological Risk Assessment for SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. January 10, 2007.
- Baker. 2006c. *Final Steps 3b and 4 of the Baseline Ecological Risk Assessment at SWMU 45, Naval Activity Puerto Rico, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. July 26, 2006.

- Baker. 2003. *Final Corrective Measures Study Investigation Report for SWMU 9, Naval Station Roosevelt Roads, Ceiba, Puerto Rico*. April 25, 2003.
- Baker. 1999. *Revised Draft RCRA Facility Investigation Report for Operable Unit 3/5, Naval Station, Roosevelt Roads, Puerto Rico*. Coraopolis, Pennsylvania. April 1, 1999.
- Baker. 1995. *Final RCRA Facility Investigation, Naval Station Roosevelt Roads, Ceiba, Puerto Rico*. Coraopolis, Pennsylvania. September 14, 1995.
- Barnthouse, L.W. and G.W. Suter II. 1996. *Guide for Developing Data Quality Objectives for Ecological Risk Assessment at DOE Oak Ridge Operations Facilities*. Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-185/R1.
- Berry, W.J., D.J. Hansen, J.D. Mahony, D.L. Robson, D.M. Di Toro, B.P. Shipley, B. Rogers, J.M. Corbin, and W.S. Boothman. 1996. Predicting the Toxicity of Metal-Spiked Laboratory Sediments Using Acid-Volatile Sulfide and Interstitial Water Normalizations. *Environ. Toxicol. Chem.* 15:2067-2079.
- Berry, W.J., M.G. Cantwell, P.A. Edwards, J.R. Serbst, and D.J. Hansen. 1999. Predicting Toxicity of Sediments Spiked with Silver. *Environmental Toxicology and Chemistry* 18(1):40-48.
- Berry, W.J., D.J. Hansen, J.D. Mahony, D.L. Robson, D.M. Di Toro, B.P. Shipley, B. Rogers, J.M. Corbin, and W.S. Boothman. 1996. Predicting the Toxicity of Metal-Spiked Laboratory Sediments Using Acid-Volatile Sulfide and Interstitial Water Normalizations. *Environ. Toxicol. Chem.* 15:2067-2079.
- Beyer, N., E. Connor, and S. Gerould. 1994. *Estimates of Soil Ingestion by Wildlife*. Patuxent Wildlife Research Center, Lauren, MD.
- Beyer, W.N., G. Hensler, and J. Moore. 1987. Relation of pH and Other Soil Variables to Concentrations of Pb, Cu, Zn, Cd, and Se in Earthworms. *Pedobiologia*. 30:167-172.
- Blakemore, R.J. 2005. *Tables of Hawaiian and Puerto Rican Earthworms*. 7 pp. May 2005.
- Bloom, N.S. 1990. On the Chemical Form of Mercury in Edible Fish and Marine Invertebrate Tissue. *Can. J. Fish. Aquat. Sci.* 49:1010-1017.
- Boyd, W. and P.L. Williams. 2003. Availability of Metals to the Nematode *Caenorhabditis elegans*: Toxicity Based on Total Concentrations in Soil and Extracted Fractions. *Environ. Toxicol. Chem.* 22:1100-1106.
- Braun-Blanquet, J. 1972. *Plant Sociology: The Study of Plant Communities*. (Transl. by G.D. Fuller and H.S. Conard). Hafner Publications, London. 439p.
- Broos, K., M.S.J. Warne, D.A. Heemsbergen, D. Stevens, M.B. Barnes, R.L. Correl, and M.J. McLaughlin. 2007. Soil Factors Controlling the Toxicity of Copper and Zinc to Microbial Processes in Australian Soils. *Environ. Toxicol. Chem.* 26:583-590.
- Buchman, M.F. 1999. *NOAA Screening Quick Reference Tables*. NOAA HAZMAT Report 99-1. Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, Seattle, WA. 12 pp.

- California Environmental Protection Agency (CEPA). 2004. *Overview of Freshwater and Marine Toxicity Tests: A Technical Tool for Ecological Risk Assessment*. April 2004.
- Capiomont, A., L. Piazzini, and G. Pergent. 2000. Seasonal Variations of Total Mercury in Foliar Tissues of *Posidonia oceanica*. *J. Mar. Bio. Ass. U.K.* 80: 1119-1123.
- Chatterjee, A. B. Bhattacharya, and R. Das. 2001. Temporal and Organ-Specific Variability of Selenium in Marine Organisms From the Eastern Coast of India. *Adv. Environ. Res.* 5:167-174.
- Chief of Naval Operations (CNO). 1999. *Navy Policy for Conducting Ecological Risk Assessments*. Memorandum from Chief of Naval Operations to Commander, Naval Facilities Engineering Command. Ser. N453E/9U595355. April 5, 1999.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. FWS/OBS-79-31. Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior, Washington, DC.
- Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (Formerly Naval Station Roosevelt Roads)*. April 2007.
- Di Toro, D.M., C.S. Zarba, D.J. Hanses, W.J. Berry, R.C. Swartz, C.E. Cowan, S.P. Pavlou, H.E. Allen, N.A. Thomas, and P.R. Paquin. 1991. Technical Basis for Establishing Sediment Quality Criteria for Nonionic Organic Chemicals Using Equilibrium Partitioning. *Environ. Toxicol. Chem.* 10:1541-1583.
- Dunning, J.B., Jr. (editor). 1993. *CRC Handbook of Avian Body Masses*. CRC Press, Boca Raton, FL. 371 pp.
- Edens, F.W. and J.D. Garlich. 1983. Lead-Induced Egg Production Decrease in Leghorn and Japanese Quail Hens. *Poult. Sci.* 62(9):1757-1763.
- Efroymson, R.A., Will, M.E., Suter II, G.W., and Wooten, A.C. 1997a. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*. Oak Ridge National Laboratory. Oak Ridge, TN. (ES/ER/TM-85/R3).
- Efroymson, R.A., Will, M.E., and Suter II, G.W. 1997b. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision*. Oak Ridge National Laboratory, Oak Ridge, TN. (ES/ER/TM-126/R2).
- Eisler, R. 1998a. *Copper Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service Biological Report 10 (1.12), Contaminant Hazard Reviews Report No. 33. 98 pp.
- Eisler, R. 1998b. *Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service Biological Report 15 (1.14), Contaminant Hazard Reviews Report No. 14. 134 pp.
- Eisler, R. 1988. *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service Biological Report 85(1.12), Contaminant Hazard Reviews Report No. 12. 92 pp.

- Eisler, R. 1985. *Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish and Wildlife Service Biological Report 85(1.2), Contaminant Hazard Reviews. Report No. 2. 46 pp.
- Etheridge, K., G.B. Rathbun, J.A. Powell, and H.I. Kochman. 1985. Consumption of Aquatic Plants by the West Indian Manatee. *J. of Aquat. Plant Manage.* 23: 21-25.
- Ewel, J.J., and J.L. Whitmore. 1973. *The Ecological Life Zones of Puerto Rico and the U.S. Virgin Islands*. Institute of Tropical Forestry, Rio Piedras, PR. (U.S. Forest Service Research Paper ITF-18).
- Ferrat, L., A. Bingert., M. Romeo., M. Gnassia-Barelli, and C. Pergent-Martini. 2002. Mercury Uptake and Enzymatic Response of *Posidonia oceanica* After an Experimental Exposure to Organic and Inorganic Forms. *Environ. Toxicol. Chem.* 21:2365-2371.
- Friday, G.P. 1998. *Ecological Screening Values for Surface Water, Sediment, and Soil*. Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-TR-98-00110.
- Geo-Marine, Inc. 2005. *Draft Environmental Assessment for the Disposal of Naval Activity Puerto Rico (Formerly Naval Station Roosevelt Roads)*. Geo-Marine, Inc., Plano, TX. December 2005.
- Geo-Marine, Inc. 2000. *Habitat Characterization of Solid Waste Management Units (SWMU) 1, SWMU 2, and SWMU 45, Naval Station Roosevelt Roads, Puerto Rico*. Geo-Marine, Inc., Plano, TX. October 11, 2000.
- Geo-Marine, Inc. 1998. *Integrated Natural Resource Management Plan for U.S. Naval Station Roosevelt Roads: Plan Years 1998-2007*. Geo-Marine, Inc., Plano, TX.
- Gilmour, C.C., E.A. Henry, and R. Mitchell. 1992. Sulfate Stimulation of Mercury Methylation in Freshwater Sediments. *Environ. Toxicol. Chem.* 26:2281-2287.
- Gilmour, C.C. and E.A. Henry. 1991. Mercury Methylation in Aqueous Systems Affected by Acid Rain. *Environ. Pollut.* 71:131-169.
- Grieb, T., C. Driscoll, S. Gloss, C. Schofield, G. Bowie, and D. Porcella. 1990. Factors Affecting Mercury Accumulation in Fish in the Upper Michigan Peninsula. *Environ. Toxicol. Chem.* 9:919-930.
- Hansen, D.J., W.J. Berry, J.D. Mahony, W.S. Boothman, D.M. Di Toro, D.L. Robson, G.T. Ankley, D. Ma, Q. Yan, and C.E. Pesch. 1996. Predicting the Toxicity of Metal-Contaminated Field Sediments Using Interstitial Concentrations of Metals and Acid-Volatile Sulfide Normalizations. *Environ. Toxicol. Chem.* 15:2080-2094.
- Heinz, G.H. 1975. Effects of Methylmercury on Approach and Avoidance Behavior of Mallard Ducklings. *Bull. Environ. Contam. Toxicol.* 13:554-564.
- Heinz, G.H. 1976a. Methylmercury: Second-Year Feeding Effects on Mallard Reproduction and Duckling Behavior. *J. Wildl. Manag.* 40(1):82-90.
- Heinz, G.H. 1976b. Methylmercury: Second-Generation Reproductive and Behavioral Effects on Mallard Ducks. *J. Wildl. Manag.* 40(4):710-715.

- Heinz, G.H. 1979. Methylmercury: Reproductive and Behavioral Effects on Three Generations of Mallard Ducks. *J. Wildl. Manage.* 43:394-401.
- Hill, W.R., A. J. Stewart, and G.E. Napolitano. 1996. Mercury Speciation and Bioaccumulation in Lotic Primary Producers and Primary Consumers. *Can. J. Fish. Aquat. Sci.* 53: 812-819.
- Hill, G.M., E.R. Miller, and H.D. Stowe. 1983. Effect of Dietary Zinc Levels on Health and Productivity of Gilts and Sows Through Two Parities. *J. Anim. Sci.* 57(1):130-138. Ref No. 35659.
- Hines, A.H. and K.L. Comtois. 1985. Vertical Distribution of Infauna in Sediments of a Subestuary of Central Chesapeake Bay. *Estuaries.* 8:296-304.
- Huckabee, J.W., J.W. Elwood, and S.G. Hildebrand. 1979. Accumulation of Mercury in Freshwater Biota. In: Nriagu, J. O., ed. *The Biogeochemistry of Mercury in the Environment*. Amsterdam, Elsevier North Holland. pp. 277-302.
- Humphreys, D.J. 1988. *Veterinary Toxicology, 3rd Edition*. B. Tindall, London, England. (ISBN 0702012491). 356 pp.
- Irwin, R.J., M. van Mouwerik, L. Stevens, M.D. Seese, and W. Basham. 1998. *Environmental Contaminants Encyclopedia*. National Park Service, Water Resources Division, Fort Collins, Colorado. <http://www.nature.nps.gov/hazardssafety/toxic/>.
- Jaagumagi, R. 1990. *Development of the Ontario Provincial Sediment Quality Guidelines for Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Nickel, and Zinc*. Water Resources Branch, Environment Ontario. Toronto, Ontario. 10 pp.
- John, D.A. and J.S. Leventhal. 1995. Bioavailability of Metals. In: du Bray, E.A., ed. *Preliminary Compilation of Descriptive Geoenvironmental Mineral Deposit Models*. U.S. Department of the Interior, U.S. Geological Survey, Denver, Colorado. Open-File Report 95-831. 272 pp.
- Kelly, C.A., J.W. Rudd, and M.H. Holoka. 2003. Effect of pH on Mercury Uptake by an Aquatic Bacterium: Implications for Hg Cycling. *Environ. Toxicol. Chem.* 37(13):2941-2946.
- Kemp, P.F. and R.C. Swartz. 1988. Acute Toxicity of Interstitial and Particle-Bound Cadmium to a Marine Infaunal Amphipod. *Mar. Environ. Res.* 26:135-153.
- Kimmel, C.A., L.D. Grant, C.S. Sloan, and B.C. Gladen. 1980. Chronic low level lead toxicity in the rat. 1. Maternal toxicity and peri natal effects. *Toxicol. Appl. Pharmacol.* 56(1):28-41.
- Lapota, D., D. Duckworth, and J.Q. Word. *Confounding Factors in Sediment Toxicity*. 19 pp.
- Levy, D.J. and W.H. Karasov. 1989. Digestive Responses of Temperate Birds Switched to Fruit or Insect Diets. *Auk*. 106:675-686.
- Lewis, R.R., III. 1986. *Status of Mangrove Forests, Roosevelt Roads Naval Station, Puerto Rico*. Buffalo, New York: Ecology and Environment.
- Little, E.L. and F.H. Wadsworth. 1964. *Common Trees of Puerto Rico and the Virgin Islands*. U.S. Department of Agriculture, Forest Department, Washington, D.C. Agricultural Handbook No. 249.

- Lock, K. and C.R. Janssen. 2001. Test Designs to Assess the Influence of Soil Characteristics on the Toxicity of Copper and Lead to the Oligochaete *Enchytraeus albidus*. *Ecotoxicol.* 10:137-144.
- Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. *Environ. Management.* 19(1):81-97.
- Luoma, S.N. 1983. Bioavailability of Trace Metals – A Review. *Sci. Total Environ.* 28:1.
- Ma, W.C. 1994. Sublethal Toxic Effects of Copper on Growth, Reproduction and Litter Breakdown Activity in the Earthworm *Lumbriculus rubellus*, With Observations on the Influence of Temperature and Soil pH. *Environ. Pollut.* 33:207-219.
- Mac, M.J., P.A. Opler, C.E. Puckett Haecker, and P.D. Doran. 1998. *Status and Trends of the Nation's Biological Resources*. 2 Vols. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va. <http://www.nwrc.usgs.gov/sandt/index.html>.
- MacDonald, D.D. 1994. *Approach to the Assessment of Sediment Quality in Florida Coastal Waters*. Florida Department of Environmental Protection. Office of Water Quality. 199 pp.
- Mahan, D.C. and A.L. Moxon. 1984. Effect of Inorganic Selenium Supplementation on Selenosis in Postweaning Swine. *J. Anim. Sci.* 58(5):1216-1221.
- Maher, W., S. Baldwin., M. Deaker, and M. Irving. 2004. Characteristics of Selenium in Australian Marine Biota. *Appl. Organomet. Chem.* 6:103-112.
- Maiz, I., I. Arambarri, R. Garcia, and E. Millan. 2000. Evaluation of Heavy Metal Availability in Polluted Soils by Two Sequential Extraction Procedures Using Factor Analysis. *Environ. Pollut.* 110:3-9.
- May, K., M. Stoeppler, and K. Reisinger. 1987. Studies in the Ratio Total Mercury/Methylmercury in the Aquatic Food Chain. *Environ. Toxicol. Chem.* 13:153-159.
- Mignucci-Giannoni, A.A. and C.A. Beck. 1998. The Diet of the Manatee (*Trichechus manatus*) in Puerto Rico. *Mar. Mam. Sci.* 14:394-397.
- Ministry of Housing, Spatial Planning and Environment (MHSPE). 2000. *Circular on Target Values and Intervention Values for Soil Remediation*. Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, Netherlands. February 4, 2000.
- Nagy, K.A. 2001. Food Requirements of Wild Animals: Predictive Equations for Free-Living mammals, Reptiles and Birds. *Nutr. Abstr. Rev. B.* 71:21R-32R.
- Naval Energy and Environmental Support Activity (NEESA). 1984. *Initial Assessment Study of Naval Station Roosevelt Roads, Puerto Rico*. NEESA 13-051.
- Naval Facilities Engineering Command (NAVFAC). 2006. *Biological Assessment for the Disposal of Naval Station Roosevelt Roads/Naval Activity Puerto Rico (Final Report)*. Naval Facilities Engineering Command Atlantic, Norfolk, VA.

- Naval Facilities Engineering Service Center (NFESC). 2000. *Guide for Incorporating Bioavailability Adjustments into Human Health and Ecological Risk Assessments at U.S. Navy and Marine Corps Facilities. Part 1: Overview of Metals Bioavailability*. Naval Facilities Engineering Command, Washington, D.C. NFESC User's Guide UG-2041-ENV.
- NFESC. 1996. *Survey of Potential Habitat for Yellow-Shouldered Blackbird on U.S. Naval Station Roosevelt Road, Puerto Rico*. Naval Facilities Engineering Command, Atlantic Division, Norfolk, VA.
- Neiger, R.D. and G.D. Osweiler. 1989. Effect of Subchronic Low Level Dietary Sodium Arsenite on Dogs. *Fund. Appl. Toxicol.* 13:439-451.
- Odell, D.K. 1992. West Indian Manatee. Pages 828 to 837 in Chapman, J.A. and Feldhamer, G.A. (eds.). *Wild Mammals of North America: Biology, Management and Economics*. The Johns Hopkins University Press, Baltimore, MD.
- Palmer, M.A. and R.M. Molloy. 1996. Water Flow and the Vertical Distribution of Meiofauna: A Flume Experiment. *Estuaries*. 9(3):225-228.
- Pannhorst, T.S. and J.H. Weber. 1999. Speciation of Mercury in Eelgrass (*Zostera maina* L.): A Seasonal Study in the Great Bay Estuary, New Hampshire. *Appl. Organomet. Chem.* 13: 461-467.
- Parker, N., G. McDermott, and D. Neptune. 2003. *U.S. Navy Ecological Screening and COPC Refinement for Sediment, Soil, and Surface Water*. 18 pp.
- Parks, J.W., A. Lutz, and J.A. Sutton. 1989. Water Column Methylmercury in the Wabigoon/English River-Lake System: Factors Controlling Concentrations, Speciation, and Net Production. *Can. J. Fish. Aquat. Sci.* 46:2184-2202.
- Pereira, A.A., B. van Hattum, A. Brouwer, P.M. van Bodegom, C.E. Rezende, and W. Salomons. 2008. Effects of Iron-Ore Mining and Processing on Metal Bioavailability in a Tropical Coastal Lagoon. *J. Soils Sediments*. 8(4):239-252.
- Puerto Rico Department of Natural Resources (PRDNR). 2002. Memorandum from Eduardo A. Ventosa-Febles to Jose L. Chabert, Director of Wildlife Division. August 12, 2002.
- Purkerson, D.G., M.A. Doblin, S.M. Bollens, S.N. Luoma, and G.A. Cutter. 2003. Selenium in San Francisco Bay Zooplankton: Potential Effects of Hydrodynamics and Food Web Interactions. *Estuaries*. 26:956-969.
- Raffaele, H.A. 1989. *A Guide to the Birds of Puerto Rico and the Virgin Islands*. Princeton University Press, Princeton, N.J. 254 pp.
- Reid, J.P., D. Easton, W.J. Kenworthy. 2001. *Manatee and Seagrass Habitat Characterization in Puerto Rico*. Department of the Navy and US Geological Survey Interagency Report, Agreement No. 320723L87. September 2001. 34 pp.
- Reid, J.P. and C.R. Kruer. 1998. *Mapping and Characterization of Nearshore Benthic Habitats Around Vieques Island, Puerto Rico, Report to Navy*. U.S. Geological Survey Biological Resource Discipline, Sirenia Project, Gainesville, Florida.

- Rhoads, F.M., S.M. Olson, and A. Manning. 1989. Copper Toxicity in Tomato Plants. *J. Environ. Qual.* 18:195-197.
- Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision*. Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.
- Scott-Fordsmand, J.J., J.M. Weeks, and S.P. Hopkin. 2000. Importance of Contamination History for Understanding Toxicity of Copper, to Earthworm *Eisenia fetida* (Oligochaeta: annelid), Using Neutral-Red Retention Assay. *Environ. Toxicol. Chem.* 19:1174-1780.
- Sellers, P., C.A. Kelly, J.W.M. Rudd, and A.R. MacHutchon. 1996. Photodegradation of Methylmercury in Lakes. *Nature*. 380:694-697.
- Sibley, P.K., G.T. Ankley, A.M. Cotter, and E.N. Leonard. 1996. Predicting Chronic Toxicity of Sediments Spiked with Zinc: An Evaluation of the Acid-Volatile Sulfide Model using a Life-Cycle Test with the Midge *Chironomus tetans*. *Environ. Toxicol. Chem.* 15(12):2102-2112.
- Stafford, E.A. and C.A. Edwards. 1985. *Comparison of Heavy Metal Uptake by Eisenia fetida with that of Other Common Earthworms*. Final Technical Report. Contract No. DAJA 45-84-C-0027. Potthamsted Experimental Station, Harpenden Herts, United Kingdom.
- Sundby, B., C. Vale, I. Cacador, F. Catarino, M.J. Madureira, and M. Caetano. 1998. Metal-Rich Concretions of the Roots of Aalt Marsh Plants: Mechanisms and Rate of Formation. *Limnol. And Oceanogr.* 43(2):245-252.
- Swartz, R.C., G.R. Didsworth, D.W. Schults, and J.O. Lamberson. 1985. Sediment Toxicity to a Marine Infaunal Amphipod: Cadmium and its Interaction with Sewage Sludge. *Mar. Environ. Res.* 18:133-153.
- Tolson, P.J. 2004. *Surveys for the Puerto Rican Boa, Epicrates inornatus, and the Virgin Islands Boa, Epicrates monensis granti, at the U.S. Naval Base, Roosevelt Roads, Puerto Rico*. Prepared for Geo-Marine, Inc., Plano, Texas.
- United Nations Environmental Program (UNEP). 1995. *Regional Management Plan for the West Indian Manatee, Trichechus manata*. Caribbean Environment Programme Technical Report No. 35. Kingston, Jamaica. <http://www.cep.unep.org/pubs/Techreports/tr35en/index.html>.
- U.S. Army Corps of Engineers (USACE). 1987. *Corps of Engineers Wetlands Delineation Manual*. Technical Report Y-87-1. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.
- United States Environmental Protection Agency (USEPA). 2009a. ProUCLVersion 4.00.04. February 2009. <http://www.epa.gov/esd/tsc/software.htm>.
- USEPA. 2009b. ProUCLVersion 4.00.04 User Guide (Draft). EPA/600/R-07/038. February 2009. <http://www.epa.gov/esd/tsc/images/ProcUCL%204.00.04/ProUCL%20Version%204.00.04%20User%20Guide.pdf>.
- USEPA. 2007a. *Ecological Soil Screening Levels for Copper (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-68. February 2007.

USEPA. 2007b. *Ecological Soil Screening Levels for Selenium (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

USEPA. 2007c. *Ecological Soil Screening Levels for Zinc (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73. June 2007.

USEPA. 2006. Ecological Risk Assessment Frequently Asked Questions: Ecological Receptors. <http://www.epa.gov/reg3hwmd/risk/eco/faqs/ecorecept.html>.

USEPA. 2005a. *Ecological Soil Screening Levels for Antimony (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-61. February 2005.

USEPA. 2005b. *Ecological Soil Screening Levels for Arsenic (Interim Final)*. Office of Solid Waste and Emergency response, Washington, D.C. OSWER Directive 9285.7-62.

USEPA. 2005c. *Ecological Soil Screening Levels for Cadmium (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65. March 2005.

USEPA. 2005d. *Ecological Soil Screening Levels for Lead (Interim Final)*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70. March 2005.

USEPA. 2005e. *Evaluation of Metals Data for the Contract Laboratory Program (CLP)*. SOP HW-2, Revision 13. September 2005.

USEPA. 2005f. *Guidance for Developing Ecological Soil Screening Levels*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-55.

USEPA. 2003. *Guidance for Developing Ecological Soil Screening Levels*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 92857-55.

USEPA. 2001a. *Method for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-Associated Contaminants with the Amphipod *Leptocheirus plumulosus**. EPA 600/R-01/020.

USEPA. 2001b. *Validating Semivolatile Organic Compounds by SW-846 Method 8270*. SOP HW-22, Revision 2. June 2001.

USEPA. 2000a. *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Status and Needs*. Office of Water and Office of Solid Waste. EPA 823-R-00-001.

USEPA. 2000b. *Draft Ecological Soil Screening Level Guidance*. Office of Emergency and Remedial Response, Washington, D.C. July 2000.

USEPA. 2000c. *Data Quality Objectives Process for Hazardous Waste Site Investigations*. EPA QA/G-4HW. EPA/600/R-00/007.

USEPA. 2000d. *Guidance for the Data Quality Objectives Process*. EPA QA/G-4. EPA/600/R-96/055.

USEPA. 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. Office of Solid Waste and Emergency Response. 530-D-99-001A. August 1999.

- USEPA. 1998. *Guidelines for Ecological Risk Assessment*. Risk Assessment Forum, Washington, DC. EPA/630/R-95/002B.
- USEPA. 1997a. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final)*. Office of Solid Waste and Emergency Response. EPA/540/R-97-006.
- USEPA. 1997b. *Mercury Study Report to Congress. Volume VI: An Ecological Assessment for Anthropogenic Mercury Emissions in the United States*. Office of Air Quality Planning and Standards and Office of Research and Development, Washington, D.C. EPA-452/R-97-008.
- USEPA. 1995. *Validating Pesticide/PCB Compounds by SW-846 Method 8080A*. SOP HW-23, Revision 0. May 1995.
- USEPA. 1993. *Wildlife Exposure Factors Handbook*. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.
- USEPA. 1981. *The Carcinogen Assessment Group's Final Risk Assessment on Arsenic*. Office of Health and Environmental Assessment, Washington, D.C. PB 81-206013.
- U.S. Fish and Wildlife Service. (USFWS). 2009. Threatened and Endangered Animals and Plants. Species Information. <http://www.fws.gov/endangered/wildlife.html>. Accessed: July 15, 2009.
- USFWS. 1996a. *Recovery Plan for the Yellow-Shouldered Blackbird (Agelaius xanthomus)*. USFWS, Southeast Region, Atlanta, GA.
- USFWS. 1996b. *Revised Recovery Plan for the Atlantic Coast Population of the Piping Plover (Charadrius melodus)*. USFWS, Region 5, Hadley, MA.
- USFWS. 1996c. *Species Account for the West Indian Manatee (Trichechus manatus)*. USFWS.
- USFWS. 1987. Endangered and Threatened Wildlife and Plants: Determination of Threatened Status for the Puerto Rican Crested Toad. *Federal Register*. 52 (149): 28828-28831.
- USFWS. 1986a. *Puerto Rico Boa Recovery Plan*. USFWS, Southeast Region, Atlanta, GA.
- USFWS. 1986b. *Recovery Plan for the Puerto Rico Population of the West Indian (Antillean) Manatee (Trichechus manatus manatus L.)*. USFWS, Southeast Region, Atlanta, GA.
- USFWS. 1984. *Recovery Plan for the Golden Coqui (Eleutherodactylus jasper)*. USFWS, Southeast Region, Atlanta, GA.
- USFWS. 1983. *Yellow-Shouldered Blackbird Recovery Plan*. USFWS, Southeast Region, Atlanta, GA.
- United States Geological Survey (USGS). 2000. Personal Correspondence with Cathy Beck, USGS. Biological Resources Division. Florida Caribbean Science Center, Sirenia Project, Gainesville, FL.

- Warren, L.A., P.M. Outridge, and A.P. Zimmerman. 1994. Geochemical Partitioning and Bioavailability of Copper to Aquatic Plants in an Artificial Oxide-Organic Sediment. *Hydrobiologia*. 304(3):197-207.
- Watras, C.J. and N.S. Bloom. 1992. Mercury and Methylmercury in Individual Zooplankton: Implications for Bioaccumulation. *Limnol. Oceanogr.* 37(6):1313-1318.
- Winfrey, M.R. and J.W.M. Rudd. 1990. Environmental Factors Affecting the Formation of Methylmercury in Low pH Lakes. *Environ. Toxicol. Chem.* 9:853-869.
- Wetmore, A. 1916. Birds of Puerto Rico. *U.S. Department of Agriculture Bull.* 326:1-140.
- Wobeser, G., O. Nielson, and B. Schiefer. 1976. Mercury and Mink II. Experimental Methyl Mercury Intoxication. *Can. J. Comp. Med.* 34-35.
- Wood, T.S. and M.L. Shelley. 1999. A Dynamic Model of Bioavailability in Constructed Wetland Sediments. *Ecol. Eng.* 12:231-252.
- Woods, C.A., G.B. Rathbun, T. Carr, and N. Carr. 1984. *Distribution and Abundance of Manatees and Sea Turtles at Roosevelt Roads Naval Station, Puerto Rico, Progress Report*. U.S. Navy Facilities Planning and Real Estate Division, Norfolk, Virginia.
- Wright, D.R. and R.D. Hamilton. 1992. Release of Methyl Mercury from Sediments: Effects of Mercury Concentration, Low Temperature, and Nutrient Addition. *Can. J. Fish. Aquat. Sci.* 39:1459-1466.
- Xun, L., N. Cambell, and J.W. Rudd. 1987. Measurements of Specific Rates of Net Methyl Mercury Production in the Water Column and Surface Sediments of Acidified and Circumneutral Lakes. *Can. J. Fish. Aquat. Sci.* 44:750-757.
- Yuhas, E.M., R.C. Schnell, and T.S. Miya. 1979. Dose-Related Alterations in Growth and Mineral Disposition by Chronic Oral Cadmium Administration in the Male Rat. *Toxicol.* 12(1):19-29.
- Zillioux, E.J., D.B. Porcella, J.M. Benoit. 1993. Mercury Cycling and Effects in Freshwater Wetland Ecosystems. *Environ. Toxicol. Chem.* 12:2245-2264.

TABLES

TABLE 2-1
LIST OF BIRDS REPORTED FROM OR HAVING THE POTENTIAL TO OCCUR AT
NAVAL ACTIVITY PUERTO RICO
SWMU 2 – LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Common Name ⁽¹⁾		
Pied-billed grebe	Red-billed tropicbird	Brown pelican ⁽²⁾
Brown booby	Magnificent frigatebird	Great blue heron
Louisiana heron	Snowy egret	Great egret
Striated heron	Little blue heron	Cattle egret
Least bittern	Yellow-crowned night heron	Black-crowned night heron
White-cheeked pintail	Blue-winged teal	American widgeon
Red-tailed hawk	Osprey	Merlin
Clapper rail	American coot	Caribbean coot
Common gallinule	Piping plover ⁽³⁾⁽⁴⁾	Semipalmated plover
Black-bellied plover	Wilson's plover	Killdeer
Ruddy turnstone	Black-necked stilt	Whimbrel
Spotted sandpiper	Semipalmated sandpiper	Short-billed dowitcher
Greater yellowlegs	Lesser yellowlegs	Willet
Stilt sandpiper	Pectoral sandpiper	Laughing gull
Royal tern	Sandwich tern	Bridled tern
Least tern	Brown noddy	White-winged dove
Zenaida dove	White-crowned pigeon	Mourning dove
Red-necked pigeon	Common ground dove	Bridled quail dove
Ruddy quail dove	Caribbean parakeet	Smooth-billed ani
Yellow-billed cuckoo	Mangrove cockoo	Short-eared owl
Chuck-will's-widow	Common nighthawk	Antillean crested hummingbird
Green-throated carib	Antillean mango	Belted kingfisher

TABLE 2-1
LIST OF BIRDS REPORTED FROM OR HAVING THE POTENTIAL TO OCCUR AT
NAVAL ACTIVITY PUERTO RICO
SWMU 2 – LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Common Name ⁽¹⁾		
Gray kingbird	Loggerhead kingbird	Stolid flycatcher
Caribbean elaenia	Purple martin	Cave swallow
Barn swallow	Northern mockingbird	Pearly-eyed thrasher
Red-legged thrush	Black-whiskered vireo	American redstart
Parula warbler	Prairie warbler	Yellow warbler
Magnolia warbler	Cape May warbler	Black-throated blue warbler
Adelaide's warbler	Palm warbler	Black and white warbler
Ovenbird	Northern water thrush	Bananaquit
Striped-headed tanager	Shiny cowbird	Black-cowled oriole
Greater Antillean grackle	Yellow-shouldered blackbird ⁽²⁾	Hooded mannikin
Yellow-faced grassquit	Black-faced grassquit	Least sandpiper
Western sandpiper	Puerto Rican woodpecker	Rock dove
Puerto Rican emerald	Puerto Rican flycatcher	Pin-tailed whydah
Spice finch	Ruddy duck	Peregrine falcon
Marbled godwit	Puerto Rican lizard cuckoo	Prothonotary warbler
Green-winged teal	Orange-cheeked waxbill	Roseate tern ⁽³⁾⁽⁴⁾
Least grebe	West Indian whistling duck	Puerto Rican screech owl
Puerto Rican tody	Green heron	

Notes:

- (1) List of birds taken from Geo-Marine, Inc. (1998).
- (2) Federally-designated endangered species.
- (3) Federally-designated threatened species.
- (4) Species has the potential to occur at Naval Activity Puerto Rico.

TABLE 2-2
SCREENING-LEVEL ASSESSMENT ENDPOINTS, RISK QUESTIONS, AND MEASUREMENT ENDPOINTS
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Assessment Endpoints	Risk Questions	Measurement Endpoints
Terrestrial Habitat: Survival, growth, and reproduction of terrestrial soil invertebrate communities.	Are site-related chemical concentrations in surface and subsurface soil sufficient to adversely affect terrestrial soil invertebrate communities?	Comparison of maximum chemical concentrations in surface and subsurface soil with soil screening values.
Survival, growth, and reproduction of terrestrial plant communities.	Are site-related surface and subsurface soil concentrations sufficient to adversely affect terrestrial plant communities?	Comparison of maximum chemical concentrations in surface and subsurface soil with soil screening values.
Survival, growth, and reproduction of terrestrial avian herbivores.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume terrestrial plants from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.
Survival, growth, and reproduction of terrestrial avian omnivores.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume terrestrial plants and soil invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.
Survival, growth, and reproduction of terrestrial avian carnivores.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume small mammals from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.
Survival, growth, and reproduction of terrestrial amphibian and reptile communities.	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptiles?	Qualitative examination of exposures and risks to ecological receptors occupying similar trophic levels.

TABLE 2-2
SCREENING-LEVEL ASSESSMENT ENDPOINTS, RISK QUESTIONS, AND MEASUREMENT ENDPOINTS
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Assessment Endpoints	Risk Questions	Measurement Endpoints
Estuarine Wetland: Survival, growth, and reproduction of aquatic invertebrate communities.	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect aquatic invertebrate communities?	Comparison of maximum chemical concentrations in surface water and sediment with surface water and sediment screening values.
Survival, growth, and reproduction of aquatic plant communities.	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect aquatic plant communities?	Comparison of maximum chemical concentrations in surface water and sediment with surface water and sediment screening values.
Survival, growth, and reproduction of avian invertebrate consumers.	Are site-related chemical concentrations in estuarine wetland sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume aquatic invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in sediment.
Ensenada Honda: Survival, growth, and reproduction of aquatic invertebrate communities.	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect aquatic invertebrate communities?	Comparison of maximum chemical concentrations in surface water and sediment with surface water and sediment screening values.
Survival, growth, and reproduction of aquatic plant communities.	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect aquatic plant communities?	Comparison of maximum chemical concentrations in surface water and sediment with surface water and sediment screening values.
Survival, growth, and reproduction of fish communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely affect fish communities?	Comparison of maximum chemical concentrations in surface water and sediment with surface water and sediment screening values.
Survival, growth, and reproduction of avian piscivores.	Are site-related chemical concentrations in estuarine wetland surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume fish from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface water and sediment.

TABLE 2-2
SCREENING-LEVEL ASSESSMENT ENDPOINTS, RISK QUESTIONS, AND MEASUREMENT ENDPOINTS
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Assessment Endpoints	Risk Questions	Measurement Endpoints
Survival, growth, and reproduction of mammalian herbivores.	Are site-related chemical concentrations in Ensenada Honda sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammals that may consume aquatic vegetation from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in sediment.
Survival, growth, and reproduction of reptile communities.	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptiles?	Qualitative examination of exposures and risks to ecological receptors occupying similar trophic levels.

TABLE 2-3
SUMMARY OF MEDIA AND SAMPLES EVALUATED IN THE SCREENING-LEVEL ECOLOGICAL RISK
ASSESSMENT AND STEP 3A OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Investigation	Sample Media	Sample Identification Number
1992 Supplemental Investigation	Surface Soil (0.0 to 0.5 foot-bgs)	06SS145
	Subsurface Soil (0.5 to 1.5 foot-bgs)	06SS141
		06SS143
		06SS146
		06SS147
		06SS150
		06SS153
		06SS155D
1996 RCRA Facility Investigation	Surface Soil (0.0 to 1.0-foot bgs)	2SB01-00
		2SB02-00
		2SB03-00
		2SB04-00
		2SB05-00
		2MW01-00
		2MW02-00
		2MW03-00
		2SD01 ⁽¹⁾
		2SD02 ⁽¹⁾
		2SD03 ⁽¹⁾
2003 Additional Data Collection Investigation	Estuarine Wetland Sediment	02EWSD01
		02EWSD02
		02EWSD03
		02EWSD04
		02EWSD05
		02EWSD06
		02EWSD07
		02EWSD08
		02EWSD09
	Ensenada Honda Surface Water	02OWSW01
		02OWSW02
		02OWSW03
		02OWSW04
		02OWSW05
		02OWSW06
		02OWSW07
		02OWSW08
		02OWSW09
	Ensenada Honda Sediment	02OWSD01
		02OWSD02
		02OWSD03
		02OWSD04
		02OWSD05
		02OWSD06
		02OWSD07
		02OWSD08
		02OWSD09

TABLE 2-3
SUMMARY OF MEDIA AND SAMPLES EVALUATED IN THE SCREENING-LEVEL ECOLOGICAL RISK
ASSESSMENT AND STEP 3A OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Investigation	Sample Media	Sample Identification Number
2004 Additional Data Collection Investigation	Estuarine Wetland Sediment	2EWSD10
		2EWSD11
		2EWSD12
		2EWSD13
		2EWSD14
		2EWSD15
		2EWSD16
		2EWSD17
		2EWSD18
		2EWSD19
	Subsurface Soil (1.0 to 2.0-foot bgs)	2SS01-01
		2SS02-01
		2SS03-01
		2SS05-01
		2SS07-01
	Surface Soil (0.0 to 1.0-foot bgs)	2SS01
		2SS02
		2SS03
		2SS04
		2SS05
		2SS07
		2SS09
		2SS10
		2SS11
		2SS12
		2SS13
		2SS14

Notes:

bgs = below ground surface

RCRA = Resource Conservation and Recovery Act

- ⁽¹⁾ The sample was re-designated as surface soil based on observations during the 2003 additional data collection field investigation; however, the sample identification number assigned to this sample during the 1996 RCRA facility investigation was not changed).

TABLE 2-4
ECOLOGICAL CHEMICALS OF CONCERN IDENTIFIED IN STEP 3A OF THE ECOLOGICAL RISK ASSESSMENT
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Habitat	Receptor/Receptor Group	Exposure Media	Ecological COCs
Terrestrial	Terrestrial invertebrate communities	Surface Soil	Antimony, copper, lead, mercury, and zinc
		Subsurface Soil	Antimony, copper, lead, mercury, and zinc
	Terrestrial plant communities	Surface Soil	Lead, mercury, and zinc
		Subsurface Soil	Copper, lead, and zinc
	Mourning dove (herbivore)	Surface soil and prey items	Lead, mercury, and zinc
		Subsurface Soil and prey items	Copper, lead, and zinc
	American robin (omnivore)	Surface soil and prey items	Lead, mercury, and zinc
		Subsurface Soil and prey items	Copper, lead, and zinc
Estuarine Wetland	Aquatic invertebrate communities	Surface soil and prey items	None
		Subsurface Soil and prey items	None
	Aquatic plant communities	Surface soil and prey items	None
		Subsurface Soil and prey items	None
Open Water (Ensenada Honda)	Spotted sandpiper (invertebrate consumer)	Surface soil and prey items	None
		Subsurface Soil and prey items	None
	Aquatic invertebrate communities	Sediment	Copper, lead, and zinc
		Sediment	Copper, lead, and zinc
	Aquatic plant communities	Sediment and prey items	Lead and mercury
	Fish communities	Surface water	None
		Sediment	None
	Double-crested cormorant (piscivore)	Surface water	None
		Sediment	None
	West Indian manatee (herbivore)	Sediment and prey items	None
		Sediment and prey items	Arsenic, cadmium, copper, lead, mercury, selenium, and zinc

TABLE 2-5
SURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1992 SUPPLEMENTAL
INVESTIGATION, 1996 RCRA FACILITY INVESTIGATION, AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	06SS103	2MW01	2MW02	2MW03	2SB01	2SB02	2SB03	2SB04
Sample ID	06SS145	2MW01-00	2MW02-00	2MW03-00	2SB01-00	2SB02-00	2SB03-00	2SB04-00
Sampling Date	11/17/92	10/08/96	10/08/96	10/08/96	10/08/96	10/08/96	10/08/96	10/08/96
Sample Depth (feet bgs)	0.00-0.50	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00
Metals (mg/kg)								
Antimony ⁽¹⁾	20.1 J	1.7 UJ	1.9 J	1.5 UJ	1.5 UJ	1.6 UJ	13.3 J	1.6 UJ
Copper ⁽¹⁾	739	55.1 J	110 J	109 J	54.7 J	73.6 J	374 J	180 J
Lead ⁽¹⁾⁽²⁾	4,760 J	11.6	13	60.6	16.1	35.2	1,000	156
Mercury ⁽¹⁾⁽²⁾	0.45	0.05 J	0.04 J	0.07 J	0.07 J	0.16 J	0.33 J	0.09 J
Zinc ⁽¹⁾⁽²⁾	1,440	52	107	108	62	96.3	845	231

TABLE 2-5
SURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1992 SUPPLEMENTAL
INVESTIGATION, 1996 RCRA FACILITY INVESTIGATION, AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2SB05	2SD01	2SD02	2SD03	2SS01	2SS02	2SS03	2SS04
Sample ID	2SB05-00	2SD01	2SD02	2SD03	2SS01	2SS02	2SS03	2SS04
Sampling Date	10/08/96	11/11/96	11/11/96	11/11/96	10/05/04	10/05/04	10/05/04	10/05/04
Sample Depth (feet bgs)	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00
Metals (mg/kg)								
Antimony ⁽¹⁾	2.4 J	1.7 UJ	4.8 J	3.3 J	0.98 J	0.41 J	24 J	0.18 J
Copper ⁽¹⁾	919 J	16.9	399	62.4	190	110	270	76
Lead ⁽¹⁾⁽²⁾	512	4	390 J	49.7 J	77	59	1,400	31
Mercury ⁽¹⁾⁽²⁾	0.37 J	0.04	0.14	0.05	0.18 J	0.045 J	0.23 J	0.11 J
Zinc ⁽¹⁾⁽²⁾	1,260	15.1	841	92.8	520	130	720	95

TABLE 2-5
SURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1992 SUPPLEMENTAL
INVESTIGATION, 1996 RCRA FACILITY INVESTIGATION, AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2SS05	2SS07	2SS09	2SS10	2SS11	2SS12	2SS13	2SS14
Sample ID	2SS05	2SS07	2SS09	2SS10	2SS11	2SS12	2SS13	2SS14
Sampling Date	10/05/04	10/05/04	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04
Sample Depth (feet bgs)	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00	0.00 - 1.00
Metals (mg/kg)								
Antimony ⁽¹⁾	2.8 J	0.77 J	0.34 J	0.47 J	0.97 J	0.23 J	0.19 J	0.11
Copper ⁽¹⁾	880	150	640	120	190	130	160	83
Lead ⁽¹⁾⁽²⁾	280	90	140	330	360	61	44	22
Mercury ⁽¹⁾⁽²⁾	0.15 J	0.59 J	0.13 J	0.096 J	19 J	0.57 J	0.088 J	0.11
Zinc ⁽¹⁾⁽²⁾	800	150	460	1,000	350	290	150	75

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

UJ = The analyte was analyzed for, but not detected at the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

mg/kg - milligram per kilogram

bgs = below ground surface

RCRA = Resource Conservation and Recovery Act

⁽¹⁾ Ecological chemical of concern for terrestrial plant and invertebrate direct contact exposures.

⁽²⁾ Ecological chemical of concern for terrestrial avian herbivore and omnivore dietary exposures.

TABLE 2-6
SUBSURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1992
SUPPLEMENTAL INVESTIGATION AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	06SS101	06SS102	06SS103	06SS104	06SS105	06SS106	06SS108	2SS01
Sample ID	06SS141	06SS143	06SS146	06SS147	06SS150	06SS153	06SS155D	2SS01-01
Sample Date	11/17/92	11/17/92	11/17/1992	11/17/92	11/17/92	11/17/92	11/17/92	10/05/04
Depth Range (ft bgs)	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.67	1.00 - 2.00
Metals (mg/kg)								
Antimony ⁽¹⁾	17.9 J	6.3 J	19.8 J	2.4 UJ	4 UJ	2.6 UJ	3 J	0.27 J
Copper ⁽¹⁾⁽²⁾	5,850	227	774	4.3 B	136	77.8	54.5	180
Lead ⁽¹⁾⁽²⁾	1,210 J	130 J	5,850 J	3.1	7.5	77.4	5.6	110
Mercury ⁽¹⁾	0.15 U	0.15 U	0.68	0.12 U	0.16 U	0.12 U	0.13 U	0.11 J
Zinc ⁽¹⁾⁽²⁾	3,350	200	2,010	8.3	89.2	206	40.7	270

TABLE 2-6
SUBSURFACE SOIL ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM THE 1992
SUPPLEMENTAL INVESTIGATION AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2SS02	2SS03	2SS05	2SS07
Sample ID	2SS02-01	2SS03-01	2SS05-01	2SS07-01
Sample Date	10/05/04	10/05/04	10/05/04	10/05/04
Depth Range (ft bgs)	1.00 - 2.00	1.00 - 2.00	1.00 - 2.00	1.00 - 2.00

Metals (mg/kg)

Antimony ⁽¹⁾	0.32 J	4.7 J	1.7 J	0.26 J
Copper ⁽¹⁾⁽²⁾	93	280	390	130
Lead ⁽¹⁾⁽²⁾	54	470	190	56
Mercury ⁽¹⁾	0.028 J	0.16 J	0.14 J	0.26 J
Zinc ⁽¹⁾⁽²⁾	160	780	660	130

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

UJ = The analyte was analyzed for, but not detected above the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

mg/kg - milligram per kilogram

bgs = below ground surface

RCRA = Resource Conservation and Recovery Act

⁽¹⁾ Ecological chemical of concern for terrestrial plant and invertebrate direct contact exposures.

⁽²⁾ Ecological chemical of concern for terrestrial avian herbivore and omnivore dietary exposures.

TABLE 2-7
STEP 2 AND STEP 3A SCREENING-LEVEL RISK ESTIMATES FOR TERRESTRIAL INVERTEBRATE AND PLANT EXPOSURES
TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 2 SURFACE SOIL
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Analyte	Contaminant Frequency/Range in Surface Soil				Value used in Step 2 Screen	Value used in Step 3a Screen	Soil Screening Value	Reference	Maximum HQ ⁽¹⁾	Mean HQ ⁽²⁾
	No. of Positive Detects/No. of Samples	Range of Positive Detections	Range of Non-Detects	Arithmetic Mean (Half Non-Detects)						
Metals (mg/kg)										
Antimony	19/24	0.11J - 24J	1.5UJ - 1.7UJ	3.42	24	3.42	5.0	Efroymson et al. 1997a	4.80	0.68
Copper	24/24	16.9 - 919J	NA	253.82	919	253.82	50.0	Efroymson et al. 1997b	18.38	5.08
Lead	24/24	2 - 4,760J	NA	412.59	4,760	412.59	50.0	Efroymson et al. 1997a	95.20	8.25
Mercury	24/24	0.04 - 19J	NA	0.96	19	0.96	0.1	Efroymson et al. 1997b	190.00	9.60
Zinc	24/24	15.1 - 1,440	NA	412.09	1,440	412.09	50.0	Efroymson et al. 1997a	28.80	8.24

Notes:

Shaded cells indicate a Hazard Quotient (HQ) greater than 1.0.

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

UJ = The analyte was analyzed for, but not detected at the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

NA = Not Applicable

HQ = Hazard Quotient

mg/kg - milligram per kilogram

⁽¹⁾ The maximum HQ was derived in Step 2 of the ecological risk assessment process by dividing the maximum detected concentration by the soil screening value.

⁽²⁾ The mean HQ was derived in Step 3a of the ecological risk assessment process by dividing the mean concentration (one-half non-detected results) by the soil screening value.

Table References:

Efroymson, R.A., Will, M.E., Suter II, G.W., and Wooten, A.C. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory. Oak Ridge, TN. (ES/ER/TM-85/R3).

Efroymson, R.A., Will, M.E., and Suter II, G.W. 1997b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. (ES/ER/TM-126/R2).

TABLE 2-8
STEP 2 AND STEP 3A SCREENING-LEVEL RISK ESTIMATES FOR TERRESTRIAL INVERTEBRATE AND PLANT EXPOSURES
TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 2 SUBSURFACE SOIL
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Analyte	Contaminant Frequency/Range in Subsurface Soil				Value used in Step 2 Screen	Value used in Step 3a Screen	Soil Screening Value	Reference	Maximum HQ ⁽¹⁾	Mean HQ ⁽²⁾
	No. of Positive Detects/No. of Samples	Range of Positive Detections	Range of Non-Detects	Arithmetic Mean (Half Non-Detects)						
Metals (mg/kg)										
Antimony	9/12	0.26J - 19.8J	2.4UJ - 4UJ	4.90	19.8	4.90	5.0	Efroymson et al. 1997a	3.96	0.98
Copper	11/12	54.5 - 5,850	4.3B	682.87	5,850	683.05	50.0	Efroymson et al. 1997b	117.00	13.66
Lead	12/12	3.1 - 5,850	NA	680.30	5,850	680.30	50.0	Efroymson et al. 1997a	117.50	13.61
Mercury	6/12	0.028J - 0.68	0.12U - 0.16U	0.15	0.68	0.18	0.1	Efroymson et al. 1997b	6.80	1.84
Zinc	12/12	8.3 - 3,350	NA	658.68	3,350	658.68	50.0	Efroymson et al. 1997a	67.00	13.16

Notes:

Shaded cells indicate a Hazard Quotient (HQ) greater than 1.0.

B = Reported values is less than the Contract Required Detection Limit, but greater than the instrument detection limit; Value is treated as not detected

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

UJ = The analyte was analyzed for, but not detected at the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

NA = Not Applicable

HQ = Hazard Quotient

mg/kg - milligram per kilogram

⁽¹⁾ The maximum HQ was derived in Step 2 of the ecological risk assessment process by dividing the maximum detected concentration by the soil screening value.

⁽²⁾ The mean HQ was derived in Step 3a of the ecological risk assessment process by dividing the mean concentration (one-half non-detected results) by the soil screening value.

Table References:

Efroymson, R.A., Will, M.E., Suter II, G.W., and Wooten, A.C. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision, Oak Ridge National Laboratory. Oak Ridge, TN. (ES/ER/TM-85/R3).

Efroymson, R.A., Will, M.E., and Suter II, G.W. 1997b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision, Oak Ridge National Laboratory, Oak Ridge, TN. (ES/ER/TM-126/R2).

TABLE 2-9
SUMMARY OF HAZARD QUOTIENT VALUES FOR AMERICAN ROBIN AND MOURNING DOVE
DIETARY EXPOSURES TO LEAD, MERCURY, AND ZINC IN SWMU 2 SURFACE SOIL
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	American Robin ⁽¹⁾			Mourning Dove ⁽¹⁾		
	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL
Metals:						
Lead	6.79	2.15	0.68	3.75	1.19	0.38
Mercury	8.82	2.79	0.88	6.77	2.14	0.68
Zinc	3.27	1.09	0.36	1.33	0.44	0.15

Shaded cells indicate a hazard quotient greater than 1.0.

Notes:

NOAEL = No Observed Adverse Effect Level

LOAEL = Lowest Observed Adverse Effect Level

MATC = Maximum Acceptable Toxicant Concentration

⁽¹⁾ The hazard quotient values shown were derived in Step 3a of the Navy ecological risk assessment process using the methodology presented in Baker (2006).

Table References:

Baker Environmental, Inc. (Baker). 2006. Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico. Coraopolis, Pennsylvania. May 18, 2006.

TABLE 2-10
SUMMARY OF HAZARD QUOTIENT VALUES FOR AMERICAN ROBIN AND MOURNING DOVE
DIETARY EXPOSURES TO COPPER, LEAD, AND ZINC IN SWMU 2 SUBSURFACE SOIL
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	American Robin ⁽¹⁾			Mourning Dove ⁽¹⁾		
	NOAEL	MATC	LOAEL	NOAEL	MATC	LOAEL
Metals:						
Copper ⁽²⁾	0.38	0.33	0.29	0.29	0.25	0.22
Lead	11.19	3.54	1.12	6.19	1.56	0.62
Zinc	5.23	1.74	0.58	2.12	0.71	0.23

Shaded cells indicate a hazard quotient greater than 1.0.

Notes:

NOAEL = No Observed Adverse Effect Level

LOAEL = Lowest Observed Adverse Effect Level

MATC = Maximum Acceptable Toxicant Concentration

⁽¹⁾ The hazard quotient values shown were derived in Step 3a of the Navy ecological risk assessment process using the methodology presented in Baker (2006).

⁽²⁾ Copper was identified as an ecological COC in Step 3a of the BERA for American robin and mourning dove dietary exposures based on the magnitude of the maximum detected concentration (5,850 mg/kg).

Table References:

Baker Environmental, Inc. (Baker). 2006. Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico. Coraopolis, Pennsylvania. May 18, 2006.

TABLE 2-11
ESTUARINE WETLAND SEDIMENT ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM
THE 2003 AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATIONS
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2EWS01	2EWS02	2EWS03	2EWS04	2EWS05	2EWS06	2EWS07	2EWS08
Sample ID	02EWSSD01	02EWSSD02	02EWSSD03	02EWSSD04	02EWSSD05	02EWSSD06	02EWSSD07	02EWSSD08
Sampling Date	07/27/03	07/27/03	07/27/03	07/27/03	07/27/03	07/27/03	07/27/03	07/27/03
Sample Depth (feet bgs)	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
Metals (mg/kg)								
Copper ⁽¹⁾	180	65	78	20	11	69	20	14
Lead ⁽¹⁾⁽²⁾	68	28	12	3.7	2.2	23	4	2.7
Mercury ⁽²⁾	0.27	0.22	0.083	0.022 J	0.027 J	0.21	0.028 J	0.015 J
Zinc ⁽¹⁾	110	110	70	21	13	66	18	16

TABLE 2-11
ESTUARINE WETLAND SEDIMENT ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM
THE 2003 AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATIONS
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2EWS09	2EWS10	2EWS11	2EWS12	2EWS13	2EWS14	2EWS15	2EWS16
Sample ID	02EWSSD09	2EWSD10	2EWSD11	2EWSD12	2EWSD13	2EWSD14	2EWSD15	2EWSD16
Sampling Date	07/27/03	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04
Sample Depth (feet bgs)	0.0 - 0.5	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33
Metals (mg/kg)								
Copper ⁽¹⁾	14	36 J	77 J	280 J	88 J	180 J	54 J	110 J
Lead ⁽¹⁾⁽²⁾	2.4	NA	NA	170	7	59	13	39
Mercury ⁽²⁾	0.022 J	NA	NA	1.3	0.064	0.35	0.05 J	0.22
Zinc ⁽¹⁾	14	NA	NA	NA	NA	NA	NA	NA

TABLE 2-11
ESTUARINE WETLAND SEDIMENT ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM
THE 2003 AND 2004 ADDITIONAL DATA COLLECTION INVESTIGATIONS
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2EWS17	2EWS18	2EWS19
Sample ID	2EWSD17	2EWSD18	2EWSD19
Sampling Date	10/04/04	10/04/04	10/04/04
Sample Depth (feet bgs)	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33

Metals (mg/kg)

Copper ⁽¹⁾	150 J	130 J	150 J
Lead ⁽¹⁾⁽²⁾	25	8.8	31
Mercury ⁽²⁾	0.2	0.036 J	0.14
Zinc ⁽¹⁾	NA	NA	NA

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

NA = Not Analyzed

mg/kg - milligram per kilogram

bgs = below ground surface

⁽¹⁾ Ecological chemical of concern for aquatic and invertebrate direct contact exposures.

⁽²⁾ Ecological chemical of concern for avian invertebrate consumer dietary exposures.

TABLE 2-12
STEP 2 AND STEP 3A SCREENING-LEVEL RISK ESTIMATES FOR AQUATIC INVERTEBRATE EXPOSURES TO
ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 2 ESTUARINE WETLAND SEDIMENT
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Analyte (1)	Contaminant Frequency/Range in Sediment				Value used in Step 2 Screen	Value used in Step 3a Screen	Sediment Screening Value	Reference	Maximum HQ ⁽¹⁾	Mean HQ ⁽²⁾
	No. of Positive Detects/No. of Samples	Range of Positive Detections	Range of Non-Detects	Arithmetic Mean (Half Non-Detects)						
Metals (mg/kg)										
Copper	19/19	11 - 280J	NA	90.84	280	90.84	18.7	MacDonald 1994	14.97	4.86
Lead ⁽³⁾	17/17	2.2 - 170	NA	29.24	170	29.24	30.2	MacDonald 1994	5.63	0.97
Zinc ⁽³⁾	9/9	13 - 110	NA	48.67	110	48.67	124.0	MacDonald 1994	0.89	0.39

Notes:

Shaded cells indicate a Hazard Quotient (HQ) greater than 1.0.

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

NA = Not Applicable

HQ = Hazard Quotient

mg/kg - milligram per kilogram

⁽¹⁾ The maximum HQ was derived in Step 2 of the ecological risk assessment process by dividing the maximum detected concentration by the soil screening value.

⁽²⁾ The mean HQ was derived in Step 3a of the ecological risk assessment process by dividing the mean concentration (one-half non-detected results) by the soil screening value.

⁽³⁾ Although the analyte's maximum and/or mean HQ is less than 1.0, this metal was identified as an ecological COC in Step 3a of the baseline ecological risk assessment based (in part) on acid volatile sulfide/simultaneously extracted metals data and statistical comparisons to background data (Baker, 2006).

Table References:

MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Florida Department of Environmental Protection. Office of Water Quality. 199 pp.

Baker Environmental, Inc. (Baker). 2006. Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico. Coraopolis, Pennsylvania. May 18, 2006.

TABLE 2-13
ENSENADA HONDA SEDIMENT ANALYTICAL DATA FOR ECOLOGICAL CHEMICALS OF CONCERN FROM
THE 2003 ADDITIONAL DATA COLLECTION INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2OW01	2OW02	2OW03	2OW04	2OW05	2OW06	2OW07	2OW08	2OW09
Sample ID	02OWSD01	02OWSD02	02OWSD03	02OWSD04	02OWSD05	02OWSD06	02OWSD07	02OWSD08	02OWSD09
Sampling Date	07/27/03	07/27/03	07/28/03	07/28/03	07/28/03	07/27/03	07/27/03	07/28/03	07/28/03
Sample Depth (feet bgs)	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
Metals (mg/kg)									
Arsenic	8.6	9.2	9.3	10	6.8	6.1	11	7.9	3.5
Cadmium	0.99 U	1.5 U	1.2 U	0.88 U	1 U	0.93 U	0.091 J	0.95 U	1.2 U
Copper	15	16	19	8	13	11	13	16	10
Lead	3.4	3.7	4.6	48	2.1	2.6	4.5	3.6	2.1
Mercury	0.033 J	0.025 J	0.034	0.016 J	0.03 J	0.0094 J	0.047 U	0.027 J	0.018 J
Selenium	0.29 J	0.42 J	0.43 J	0.38 J	0.51 J	0.3 J	0.33 J	0.36 J	0.27 J
Zinc	19	25	29	12	15	19	23	18	21

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

bgs = below ground surface

mg/kg - milligram per kilogram

TABLE 2-14
INGESTION-BASED TOXICITY REFERENCE VALUES FOR BIRDS (TERRESTRIAL AVIAN OMNIVORES AND AQUATIC AVIAN INVERTEBRATE CONSUMERS)
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	Test Material	NOAEL (mg/kg-bw/d)	MATC ⁽¹⁾ (mg/kg-bw/d)	LOAEL (mg/kg-bw/d)	Data Reference ⁽²⁾
Metals:										
Copper	Chicken	1.52	84 days	Oral in diet	Reproduction (eggs per nest)	Copper	4.05 ⁽³⁾	7.00	12.1	USEPA 2007a ⁽⁶⁾
Lead	Leghorn chicken	1.81	4 weeks	Oral in diet	Reproduction (progeny counts)	Lead Acetate	1.63 ⁽³⁾	2.31	3.26	USEPA 2005 ⁽⁶⁾
Mercury	Mallard duck	1.00	3 generations	Oral in diet	Reproduction (egg and duckling counts)	Methylmercury Dicyandiamide	0.026	0.045	0.078	USEPA, 1997 ⁽⁶⁾
	Japanese quail	0.15	6 months	Oral in diet	Reproduction (egg fertility and hatchability)	Mercuric Chloride	0.9	0.64	0.45	Sample et al., 1996 ⁽⁶⁾
Zinc	Multiple species	Various	Various	Oral in diet	Reproduction and growth	Zinc carbonate, zinc oxide, and zinc sulfate	66.1 ⁽⁴⁾	106	171 ⁽⁵⁾	USEPA, 2007b

Notes:

kg = kilogram
mg/kg-bw/day = milligram per kilogram-body weight per day
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC = Maximum Acceptable Toxicant Concentration
USEPA = United States Environmental Protection Agency

- ⁽¹⁾ MATC values were derived by calculating the geometric mean of the NOAEL and LOAEL values.
- ⁽²⁾ Data references for NOAEL and LOAEL values represent primary data sources (as reported by original authors) unless otherwise noted.
- ⁽³⁾ The value shown, selected by the USEPA as the toxicity reference value for avian ecological soil screening value development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival.
- ⁽⁴⁾ The LOAEL represents a geometric mean of all reproduction- and growth-based LOAEL values listed within the cited ecological soil screening level document. The value was calculated by Baker Environmental, Inc.
- ⁽⁵⁾ The NOAEL value represents the geometric mean of all reproduction and growth-based NOAEL values listed within the cited ecological soil screening level document (USEPA, 2007b). The value was calculated and used by the USEPA to derive the avian ecological soil screening level.
- ⁽⁶⁾ Data references for NOAEL and LOAEL values represent secondary data sources (see text in Section 2.4.1 for primary data source [i.e., original authors]).

Table References:

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Risk Assessment Program, Health Sciences Research Division. Oak Ridge, Tennessee.

United States Environmental Protection Agency (USEPA). 2007a. Ecological Soil Screening Level for Copper (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.D. OSWER Directive 9285.7-77.

USEPA. 2007b. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73.

USEPA. 2005. Ecological Soil Screening Levels for Lead (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70.

USEPA. 1997. Mercury Study Report to Congress. Volume VI: An Ecological Assessment for Anthropogenic Mercury Emissions in the United States. Office of Air Quality Planning and Standards and Office of Research and Development, Washington, D.C. EPA-452/R-97-008.

TABLE 2-15
INGESTION-BASED TOXICITY REFERENCE VALUES FOR THE WEST INDIAN MANATEE
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	Test Material	Test Species			Data Reference ⁽²⁾	Ecological Receptor	Receptor Species ⁽³⁾		
							NOAEL (mg/kg-bw/d)	MATC ⁽¹⁾ (mg/kg-bw/d)	LOAEL (mg/kg-bw/d)			NOAEL (mg/kg-bw/d)	MATC ⁽¹⁾ (mg/kg-bw/d)	LOAEL (mg/kg-bw/d)
Metals:														
Arsenic	Dog	10.1	8 weeks	Oral in diet	Growth (body weight)	Sodium Arsenite	1.04 ⁽⁴⁾	1.31	1.66	USEPA, 2005a	West Indian manatee	0.3486	0.4405	0.5564
Cadmium	Rat	0.43	2 weeks	Oral in water	Growth (body weight)	Cadmium Acetate	0.77 ⁽⁴⁾	2.44	7.70	USEPA, 2005b	West Indian manatee	0.1172	0.3708	1.1724
Copper	Pig	100	4 weeks	Oral in diet	Growth (body weight)	Copper Sulfate Pentahydrate	5.6 ⁽⁴⁾	7.23	9.34	USEPA, 2007a	West Indian manatee	3.3298	4.3002	5.5536
Lead	Rat	0.3	7 weeks	Oral in water	Growth (body weight)	Lead Acetate	4.7 ⁽⁴⁾	6.47	8.90	USEPA 2005c	West Indian manatee	0.6540	0.9000	1.2385
Mercury	Mink	1.00	93 days	Oral in diet	Mortality (weight loss)	Methyl Mercury Chloride	0.015	0.019	0.025	Sample et al., 1996	West Indian manatee	0.0028	0.0036	0.0047
	Mink	1.00	6 months	Oral in diet	Reproduction (fertility and kit weight)	Mercuric Chloride	1.0	3.2	10.0	Sample et al., 1996	West Indian manatee	0.1880	0.5946	1.8803
Selenium	Pig	17.8	37 days	Oral in diet	Growth (body weight)	Sodium selenite	0.143 ⁽⁴⁾	0.173	0.215	USEPA, 2007b	West Indian manatee	0.0552	0.0668	0.0830
Zinc	Pig	167	1 year	Oral in diet	Reproduction (offspring development)	Zinc Oxide	8.23 ⁽⁵⁾	26.0	82.3	USEPA, 2007c	West Indian manatee	5.5630	17.5920	55.6297

Notes:

kg = kilogram
mg/kg-bw/day = milligram per kilogram-body weight per day
NOAEL = No Observed Effect Level
LOAEL = Lowest Observed Effect Level
MATC = Maximum Acceptable Toxicant Concentration
USEPA = United States Environmental protection Agency

- ⁽¹⁾ MATC values were derived by calculating the geometric mean of the NOAEL and LOAEL values
- ⁽²⁾ Data references for NOAEL and LOAEL values represent secondary data sources (see text in Section 2.4.1 for primary data source [i.e., original authors]).
- ⁽³⁾ NOAEL, LOAEL, and MATC values were adjusted to reflect differences in body weights between the mammalian test species and the West Indian manatee (see Section 2.5.4).
- ⁽⁴⁾ The value shown, selected by the USEPA as the toxicity reference value for mammalian ecological soil screening value development, represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival.
- ⁽⁵⁾ See text in Section 2.4.1.8 for a description of the NOAEL value.

Table References:

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Health Sciences Research Division, Oak Ridge, TN. ES/ER/TM-86/R3.

U.S. Environmental Protection Agency (USEPA). 2007a. Ecological Soil Screening Levels for Copper (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-68.

USEPA. 2007b. Ecological Soil Screening Levels for Selenium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

USEPA. 2007c. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73.

USEPA. 2005a. Ecological Soil Screening Levels for Arsenic (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-62

USEPA. 2005b. Ecological Soil Screening Levels for Cadmium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65.

USEPA. 2005. Ecological Soil Screening Levels for Lead (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70.

TABLE 2-16
DECISION RULES FOR THE BASELINE ECOLOGICAL RISK ASSESSMENT
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Habitat	Line of Evidence	Decision Based on	Uncertainties/ Limitations/ Factors to Consider	Decision Criteria	Decision Recommendations/Actions
Terrestrial Habitat	Comparison of the spatial and statistical distributions (95% UCL of the mean concentrations) in SWMU 2 soil to literature-based toxicological thresholds	Do the 95% UCL of the mean soil concentrations exceed acceptable toxicological thresholds? What is the spatial pattern of exceedance of these criteria?	Literature-based toxicological thresholds are not site-specific (do not take into consideration site-specific factors that can influence bioavailability)	HQ > 1.0	Indication of unacceptable risk
				HQ ≤ 1.0	Indication of acceptable/minimal risk
	Comparisons of toxic response in SWMU 2 surface soil to the toxic response in reference area soil	Is there a significant reduction ($\alpha = 0.05$) in the survival, growth, and/or reproduction of <i>Eisenia fetida</i> exposed to SWMU 2 soil?	Low control or reference survival, growth, and/or reproduction - potential inability to make decision; power of toxicity and statistical tests	p < 0.05, Significant difference	Unacceptable risk identified
				p ≥ 0.05, No significant difference	Indication of acceptable/minimal risk; no further action recommended
	Demonstration of a dose-response relationship between chemical concentrations and toxicity test endpoint response variables	Does a response relationship exists (indicated by simple regression with a p < 0.05) between ecological chemicals of concern and the most sensitive of the measured response variables (survival, growth, or reproduction for <i>Eisenia fetida</i>)?	Confounding influences may include the use of inappropriate reference samples, inability of field effort to capture known concentration gradient of ecological COCs, response variables outside of concentration ranges, and physical/chemical parameters (e.g., grain size, TOC, and pH) impacting the response variable.	Significant difference (p < 0.05), low variability in response	Unacceptable risk identified
				Significant difference (p < 0.05), high variability in response	Large variability in response variable caused by confounding variables; investigation into variable impact and weight to arrive at decision point
				No significant difference (p ≥ 0.05)	Indication of acceptable/minimal risk only after investigation of the limits and uncertainties associated with the potential for confounding influences; no further action recommended
	Comparison of American robin dietary exposures (based on 95 percent UCL of the mean ecological COC concentrations in the tissue of earthworms exposed to SWMU 2 soil during toxicity testing) to literature-based toxicity reference values	Do dietary dose estimates using earthworm tissue data exceed literature-based NOAEL and LOAEL ingestion-based screening values?	Site-specific bioaccumulation; confounding influences may include earthworm exposure point concentrations (were earthworms exposed to maximum concentrations?)	Noael-based HQ > 1.0	Indication of unacceptable risk
				NOAEL-based HQ ≤ 1.0	Indication of acceptable/minimal risk
Estuarine Wetland Habitat	Comparison of the spatial and statistical distributions (95% UCL of the mean concentrations) in SWMU 2 estuarine wetland sediment to literature-based toxicological thresholds	Do the 95% UCL of the mean estuarine wetland sediment concentrations exceed acceptable toxicological thresholds? What is the spatial pattern of exceedance of these criteria?	Literature-based toxicological thresholds are not site-specific (do not take into consideration site-specific factors that can influence bioavailability)	HQ > 1.0	Indication of unacceptable risk
				HQ ≤ 1.0	Indication of acceptable/minimal risk
	Comparisons of toxic response in SWMU 2 estuarine wetland sediment to the toxic response in reference area estuarine wetland sediment	Is there a significant reduction ($\alpha = 0.05$) in the survival, growth, and/or reproduction of <i>Leptocheirus plumulosus</i> or the survival and growth of <i>Neanthes arenaceodentata</i> exposed to SWMU 2 estuarine wetland sediment?	Low control or reference survival, growth, and/or reproduction - potential inability to make decision; power of toxicity and statistical tests	p < 0.05, Significant difference	Unacceptable risk identified
				p ≥ 0.05, No Significant difference	Indication of acceptable/minimal risk; no further action recommended

TABLE 2-16
DECISION RULES FOR THE BASELINE ECOLOGICAL RISK ASSESSMENT
SWMU 2 - LANGLEY DRIVE DISPOSAL AREA
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Habitat	Line of Evidence	Decision Based on	Uncertainties/ Limitations/ Factors to Consider	Decision Criteria	Decision Recommendations/Actions
Estuarine Wetland Habitat (continued)	Demonstration of a dose-response relationship between chemical concentrations and toxicity test endpoint response variables	Does a response relationship exist (indicated by simple regression with a $p < 0.05$) between ecological chemicals of concern and the most sensitive of the measured response variables (survival, growth, or reproduction of <i>Leptocheirus plumulosus</i> ; survival or growth of <i>Neanthes arenaceodentata</i>)?	Confounding influences may include the use of inappropriate reference samples, inability of field effort to capture known concentration gradient of ecological COCs, response variables outside of concentration ranges, and physical/chemical parameters (e.g., grain size, TOC, and pH) impacting the response variable.	Significant difference ($p < 0.05$), low variability in response	Unacceptable risk identified
				Significant difference ($p < 0.05$), high variability in response	Large variability in response variable caused by confounding variables; investigation into variable impact and weight to arrive at decision point
				No significant difference ($p \geq 0.05$)	Indication of acceptable/minimal risk only after investigation of the limits and uncertainties associated with the potential for confounding influences; no further action recommended
	Comparison of spotted sandpiper dietary exposures (based on 95 percent UCL of the mean ecological COC concentrations in field collected fiddler crab tissue) to literature-based toxicity reference values	Do dietary dose estimates using fiddler crab tissue data exceed literature-based NOAEL and LOAEL ingestion-based screening values?	Site-specific bioaccumulation; confounding influences may include fiddler crab exposure point concentrations (were fiddler crabs exposed to maximum concentrations?)	MATC-based $HQ > 1.0$	Indication of unacceptable risk
				MATC-based $HQ \leq 1.0$	Indication of acceptable/minimal risk
Open Water Habitat	Comparison of West Indian manatee dietary exposures (based on maximum ecological COC concentrations in field collected turtle grass tissue samples) to literature-based toxicity reference values	Do dietary dose estimates using turtle grass data exceed literature-based NOAEL and LOAEL ingestion-based screening values?	Site-specific bioaccumulation; confounding factors may include turtle grass exposure point concentrations (was turtle grass tissue collected from areas with ecological COC concentrations representative of historical sediment data?)	NOAEL-based $HQ > 1.0$	Indication of unacceptable risk
				NOAEL-based $HQ \leq 1.0$	Indication of acceptable/minimal risk

Notes:

HQ = Hazard Quotient

UCL = Upper Confidence Limit

TOC = Total Organic Carbon

COC = Chemical of Concern

NOAEL = No Observed Adverse Effect Concentration

LOAEL = Lowest Observed Adverse Effect Levels

SWMU = Solid Waste Management Unit

TABLE 3-1
SWMU 2 AND REFERENCE AREA SOIL AND ESTUARINE WETLAND SEDIMENT SAMPLING AND ANALYTICAL PROGRAM:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Media and Type	Sample Identification	Analyses Requested									Comments
		PAHs	Appendix IX Organochlorine Pesticides	Appendix IX Metals	Sb, Cu, Pb, Hg, and Zn	Cu, Pb, Hg, and Zn	Ammonia and sulfide	TOC	Grain Size	pH	
Surface Soil Samples (Solid)	SWMU 2:										
	2V-SS01							X	X	X	
	2V-SS02							X	X	X	
	2V-SS03							X	X	X	
	2V-SS04							X	X	X	
	2V-SS05							X	X	X	
	2V-SS06							X	X	X	
	Reference Area No. 1:										
	REF-SS01	X	X	X				X	X	X	
	REF-SS01D	X	X	X							Duplicate
	REF-SS01MS	X	X	X							Matrix spike
	REF-SS01MSD	X	X	X							Matrix spike duplicate
	REF-SS02	X	X	X				X	X	X	
	REF-SS03				X			X	X	X	
	REF-SS03D				X						Duplicate
	REF-SS04				X			X	X	X	
	Reference Area No. 2:										
	REF-SS05	X	X	X				X	X	X	
	REF-SS06	X	X	X				X	X	X	
	REF-SS07				X			X	X	X	
	REF-SS08				X			X	X	X	
	Reference Area No. 3:										
	REF-SS09	X	X	X				X	X	X	
	REF-SS010	X	X	X				X	X	X	
	REF-SS011				X			X	X	X	
	REF-SS012				X			X	X	X	
Subsurface Soil (Solid)	SWMU 2:										
	2V-SB01							X	X	X	
	2V-SB02							X	X	X	
	2V-SB03							X	X	X	
	2V-SB04							X	X	X	
	2V-SB05							X	X	X	
	2V-SB06							X	X	X	

TABLE 3-1
SWMU 2 AND REFERENCE AREA SOIL AND ESTUARINE WETLAND SEDIMENT SAMPLING AND ANALYTICAL PROGRAM:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Media and Type	Sample Identification	Analyses Requested									Comments
		PAHs	Appendix IX Organochlorine Pesticides	Appendix IX Metals	Sb, Cu, Pb, Hg, and Zn	Cu, Pb, Hg, and Zn	Ammonia and sulfide	TOC	Grain Size	pH	
Subsurface Soil (Solid)	Reference Area No. 1:										
	REF-SB01	X	X	X				X	X	X	
	REF-SB01D	X	X	X							Duplicate
	REF-SB01MS	X	X	X							Matrix spike
	REF-SB01MSD	X	X	X							Matrix spike duplicate
	REF-SB02	X	X	X				X	X	X	
	REF-SB03				X			X	X	X	
	REF-SB04				X			X	X	X	
	Reference Area No. 2:										
	REF-SB06	X	X	X				X	X	X	
	REF-SB07				X			X	X	X	
	REF-SB08				X			X	X	X	
	Reference Area No. 3:										
	REF-SB09	X	X	X				X	X	X	
	REF-SB10	X	X	X				X	X	X	
	REF-SB11				X			X	X	X	
	REF-SB12				X			X	X	X	
Estuarine Wetland Sediment (Solid)	SWMU 2:										
	2V-EWSD01						X		X	X	
	2V-EWSD02						X		X	X	
	2V-EWSD03						X		X	X	
	2V-EWSD04						X		X	X	
	2V-EWSD05						X		X	X	
	2V-EWSD06						X		X	X	
	Reference Area:										
	REF-EWSD01					X	X	X	X	X	
	REF-EWSD01D					X					Duplicate
	REF-EWSD01MS					X					Matrix spike
	REF-EWSD01MSD					X					Matrix spike duplicate
	REF-EWSD02					X	X	X	X	X	
	REF-EWSD03					X	X	X	X	X	
	REF-EWSD04					X	X	X	X	X	
	REF-EWSD05					X	X	X	X	X	
	REF-EWSD06					X	X	X	X	X	

TABLE 3-1
SWMU 2 AND REFERENCE AREA SOIL AND ESTUARINE WETLAND SEDIMENT SAMPLING AND ANALYTICAL PROGRAM:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Media and Type	Sample Identification	Analyses Requested									Comments
		PAHs	Appendix IX Organochlorine Pesticides	Appendix IX Metals	Sb, Cu, Pb, Hg, and Zn	Cu, Pb, Hg, and Zn	Ammonia and sulfide	TOC	Grain Size	pH	
QA/QC Samples (Aqueous)	Equipment Rinsate Blanks:										
	1V-ER01 ⁽¹⁾	X	X	X							Stainless steel spoon
	2V-ER01 ⁽²⁾	X	X	X							Stainless steel bucket auger
	REF-ER01 ⁽¹⁾					X					Stainless steel spoon
	Field Blanks:										
	1V-FB01	X	X	X							Laboratory-grade deionized water

Notes:

Cu = Copper

Pb = Lead

Hg = Mercury

Sb = Antimony

Zn = Zinc

PAH = Polycyclic Aromatic Hydrocarbon

TOC = Total Organic Carbon

SWMU = Solid Waste Management Unit

QA/QC = Quality Assurance/Quality Control

⁽¹⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused stainless steel spoon.

⁽²⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused stainless steel hand auger.

TABLE 3-2
ANALYTICAL METHODOLOGY: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Medium/Type	Analyte	Analytical Method	Preparation Method
SWMU 2, Upland Reference Areas, and Estuarine Wetland Reference Area:			
Soil Samples (Solid)	Appendix IX PAHs (low level)	SW-846 8270C	SW-846 3550B
	Appendix IX organochlorine pesticides	SW-846 8081A	SW-846 3550B
	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Grain size	ASTM D-422	NA
	Total organic carbon	Lloyd Kahn	NA
	pH	SW-846 9045C	NA
Sediment Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Grain size	ASTM D-422	NA
	Total organic carbon	Lloyd Kahn	NA
	pH	SW-846 9045C	NA
	Ammonia	MCAWW 350.1	EPA 3-154
	Sulfide	SW-846 9034	SW-846 9030B
QA/QC Samples ⁽¹⁾ (Aqueous)	Appendix IX PAHs (low level)	SW-846 8270C	SW-846 3520C
	Appendix IX organochlorine pesticides	SW-846 8081A	SW-846 3520C
	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3005A
	Mercury	SW-846 7471A	SW-846 7471A
Open Water Reference Areas ⁽²⁾			
Sediment Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Grain size	ASTM D-422	NA
	Total organic carbon	SW-846 9060	NA
	pH	SW-846 9045C	NA
QA/QC Samples ⁽¹⁾ (Aqueous)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3005A
	Mercury	SW-846 7471A	SW-846 7471A

Notes:

QA/QC = Quality Assurance/Quality Control

MCAWW = Methods for Chemical Analysis of Wastes

ASTM = American Society for Testing and Materials

SW-846 = Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods

SWMU = Solid Waste Management Unit

PAH = Polynuclear Aromatic Hydrocarbon

EPA = Environmental Protection Agency

NA = Not Applicable

⁽¹⁾ The aqueous QA/QC samples consist of equipment rinsate and field blanks.

⁽²⁾ Open water reference area sediment samples and associated QA/QC samples were collected on September 20, 2006 and September 21, 2006 during verification of the field sampling design for a baseline ecological risk assessment at SWMU 45

TABLE 3-3
SOIL SCREENING VALUES FOR METALS, PAHS, AND ORGANOCHLORINE PESTICIDES
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Soil Screening Value	Reference	Comment
PAHs (mg/kg):			
Low Molecular Weight PAHs	29.0 ⁽¹⁾	USEPA, 2007a	Ecological soil screening level for terrestrial invertebrates
High Molecular weight PAHs	18.0 ⁽²⁾	USEPA, 2007a	Ecological soil screening level for terrestrial invertebrates
Organochlorine Pesticides (ug/kg):			
4,4'-DDD	401 ⁽³⁾	MHSPE, 2000	Value for total DDD, DDE, and DDT
4,4'-DDE	401 ⁽³⁾	MHSPE, 2000	Value for total DDD, DDE, and DDT
4,4'-DDT	401 ⁽³⁾	MHSPE, 2000	Value for total DDD, DDE, and DDT
Aldrin	400 ⁽³⁾	MHSPE, 2000	Value for total aldrin, endrin, and dieldrin
alpha-BHC	201 ⁽³⁾	MHSPE, 2000	Value for total BHC compounds
Chlordane (technical)	100	Friday, 1998	Background-based value
beta-BHC	201 ⁽³⁾	MHSPE, 2000	Value for total BHC compounds
Chlorobenzilate	NA	---	---
delta-BHC	201 ⁽³⁾	MHSPE, 2000	Value for total BHC compounds
Dieldrin	400 ⁽³⁾	MHSPE, 2000	Value for total aldrin, endrin, and dieldrin
Endosulfan I	100	Friday, 1998	Background-based value
Endosulfan II	100	Friday, 1998	Background-based value
Endosulfan sulfate	100	Friday, 1998	Background-based value
Endrin	400 ⁽³⁾	MHSPE, 2000	Value for total aldrin, endrin, and dieldrin
Endrin aldehyde	100	Friday, 1998	Background-based value
gamma-BHC (lindane)	201 ⁽³⁾	MHSPE, 2000	Value for total BHC compounds
gamma-Chlordane	100	Friday, 1998	Background-based value
Heptachlor	100	Friday, 1998	Background-based value
Heptachlor epoxide	100	Friday, 1998	Background-based value
Isodrin	100	Friday, 1998	Background-based value
Kepone	100	Friday, 1998	Background-based value
Methoxychlor	100	Friday, 1998	Background-based value
Toxaphene	100	Friday, 1998	Background-based value
Metals (mg/kg):			
Antimony	78.0	USEPA, 2005a	Ecological soil screening level for terrestrial invertebrates
Arsenic	18.0	USEPA, 2005b	Ecological soil screening level for terrestrial plants
Barium	330	USEPA, 2005c	Ecological soil screening level for terrestrial invertebrates
Beryllium	40.0	USEPA, 2005d	Ecological soil screening level for terrestrial invertebrates
Cadmium	140	USEPA, 2005e	Ecological soil screening level for terrestrial invertebrates
Chromium	57.0	USEPA, 2008	Reproduction-based MATC for <i>Eisenia andrei</i> (earthworm)
Cobalt	13.0	USEPA, 2005f	Ecological soil screening level for terrestrial plants

TABLE 3-3
SOIL SCREENING VALUES FOR METALS, PAHS, AND ORGANOCHLORINE PESTICIDES
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Soil Screening Value	Reference	Comment
Metals (mg/kg):			
Copper	80.0	USEPA, 2007b	Ecological soil screening level for terrestrial invertebrates
Lead	1,700	USEPA, 2005g	Ecological soil screening level for terrestrial invertebrates
Mercury	0.1	Efroymson et al., 1997a	Toxicological threshold for earthworms
Nickel	280	USEPA, 2007c	Ecological soil screening-level for terrestrial invertebrates
Selenium	4.1	USEPA, 2007d	Ecological soil screening-level for terrestrial invertebrates
Silver	560	USEPA, 2006	Ecological soil screening level for terrestrial plants
Thallium	1.0	Efroymson et al., 1997b	Toxicological threshold for plants
Tin	50.0	Efroymson et al., 1997b	Toxicological threshold for plants
Vanadium	10.0	USEPA, 2005h	Growth-based LOAEC for <i>Brassica oleracea</i> (broccoli) with a safety factor of 10
Zinc	120	USEPA, 2007e	Ecological soil screening-level for terrestrial invertebrates

Notes:

MHSPE = Ministry of Housing, Spatial Planning and Environment

USEPA = United States Environmental Protection Agency

LOAEC = Lowest Observed Adverse Effect Concentration

MATC = Maximum Acceptable Toxicant Concentration

ug/kg = micrograms per kilogram

mg/kg = milligram per kilogram

BHC = Benzenehexachloride

DDD = Dichlorodiphenyldichloroethane

DDE = Dichlorodiphenyldichloroethylene

DDT = Dichlorodiphenyltrichloroethane

PAH = Polycyclic Aromatic Hydrocarbon

⁽¹⁾ Low molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of fewer than four rings. The low molecular weight PAH compounds analyzed for in SWMU 1 surface soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene.

⁽²⁾ High molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of four or more rings. The high molecular weight PAH compounds analyzed for in SWMU 1 surface soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene.

⁽³⁾ The screening value shown is an average of the target and intervention soil standards. The value is based on a default organic carbon content of 0.02 (2.0 percent), which represents a minimum value (adjustment range is 2 to 30 percent).

Table references:

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revisions. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revisions. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-85/R3

TABLE 3-3
SOIL SCREENING VALUES FOR METALS, PAHS, AND ORGANOCHLORINE PESTICIDES
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Table references (continued):

Friday, G.P. 1998. Ecological Screening Values for Surface Water, Sediment, and Soil. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC. WSRC-TR-98-00110.

Ministry of Housing, Spatial Planning and Environment (MHSPE). 2000. Circular on Target Values and Intervention Values for Soil Remediation. Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, Netherlands. February 4, 2000.

United States Environmental Protection Agency (USEPA). 2008. Ecological Soil Screening Levels for Chromium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-66.

USEPA. 2007a. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

USEPA. 2007b. Ecological Soil Screening Levels for Copper (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-68.

USEPA. 2007c. Ecological Soil Screening Levels for Nickel (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-76.

USEPA. 2007d. Ecological Soil Screening Levels for Selenium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

USEPA. 2007e. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73.

USEPA. 2006. Ecological Soil Screening Levels for Silver (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-77.

USEPA. 2005a. Ecological Soil Screening Levels for Antimony (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-61.

USEPA. 2005b. Ecological Soil Screening Levels for Arsenic (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-62.

USEPA. 2005c. Ecological Soil Screening Levels for Barium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-63.

USEPA. 2005d. Ecological Soil Screening Levels for Beryllium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-64.

USEPA. 2005e. Ecological Soil Screening Levels for Cadmium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65.

USEPA. 2005f. Ecological Soil Screening Levels for Cobalt (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-67.

USEPA. 2005g. Ecological Soil Screening Levels for Lead (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70.

USEPA. 2005h. Ecological Soil Screening Levels for Vanadium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-75.

TABLE 3-4
OPEN WATER REFERENCE AREA SEDIMENT SAMPLING AND ANALYTICAL PROGRAM:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Media/Type	Sample Identification ⁽¹⁾	Analyses Requested			Comments
		As, Cd, Cu, Pb, Hg, Se, and Zn	Total Organic Carbon	Grain Size	
Sediment Samples (Solid)	Reference Area No. 1:				
	REF1-SD01V	X	X	X	
	REF1-SD02V	X	X	X	
	REF1-SD03V	X	X	X	
	REF1-SD04V	X	X	X	
	REF1-SD05V	X	X	X	
	REF1-SD06V	X	X	X	
	Reference Area No. 2:				
	REF2-SD01V	X	X	X	
	REF2-SD02V	X	X	X	
	REF2-SD03V	X	X	X	
	REF2-SD04V	X	X	X	
	REF2-SD04VD	X			Duplicate
	REF2-SD04VMS	X			Matrix spike
	REF2-SD04VMUSD	X			Matrix spike duplicate
	REF2-SD05V	X	X	X	
	REF2-SD06V	X	X	X	
	Reference Area No. 3:				
	REF3-SD01V	X	X	X	
	REF3-SD01VD	X			Duplicate
	REF3-SD02V	X	X	X	
QA/QC Samples (Aqueous)	Equipment Rinsate Blanks:				
	45B-ER01V ⁽²⁾	X			Sediment core liner
	Field Blanks:				
	45B-FB01V	X			Laboratory-grade deionized water

Notes:

As = Arsenic Hg = Mercury
Cd = Cadmium Se = Selenium
Cu = Copper Zn = Zinc
Pb = Lead QA/QC = Quality Assurance/Quality Control

⁽¹⁾ Open water reference area sediment samples and associated QA/QC samples were collected on September 20, 2006 and September 21, 2006 during verification of the field sampling design for a BERA at SWMU 45. Analytical data from this sampling event were used to identify an appropriate open water reference area for the BERA at SWMU 2.

⁽²⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused sediment core liner.

TABLE 3-5
UPLAND AND ESTUARINE WETLAND SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested														
Sample Media/ Type	Sample Identification	Sb, Cu, Pb, Hg, and Zn	Earthworm Toxicity Test	Cu, Pb, Hg, and Zn	Amphipod Toxicity Test	Polychaete Toxicity Test	As, Cd, Cu, Pb, Hg, Se, and Zn	Pb and Hg	Sb, As, Cd, Cu, Pb, Hg, Se, and Zn	AVS/SEM	TOC	Grain Size	pH	Ammonia and Sulfide	Percent Lipids	Comments
Surface Soil Samples (Solid)	SWMU 2:															
	2B-SS01	X														Historic sample location 2SS03/06SS103
	2B-SS02	X														Grid location near 2SS03/06SS103
	2B-SS03	X														Grid location near 2SS03/06SS103
	2B-SS04	X	X								X	X	X			Grid location near 2SS03/06SS103
	2B-SS04D	X														Duplicate
	2B-SS05	X	X								X	X	X			Grid location near 2SS03/06SS103
	2B-SS06	X														Historic sample location 06SS101
	2B-SS07	X														Grid location near 06SS101
	2B-SS08	X														Grid location near 06SS101
	2B-SS09	X														Grid location near 06SS101
	2B-SS10	X	X								X	X	X			Grid location near 06SS101
	2B-SS11	X														Historic sample location 2SS11
	2B-SS12	X														Grid location near 2SS11
	2B-SS13	X	X								X	X	X			Grid location near 2SS11
	2B-SS14	X	X								X	X	X			Grid location near 2SS11
	2B-SS14MS	X														Matrix spike
	2B-SS14MSD	X														Matrix spike duplicate
	2B-SS14D	X														Duplicate
	2B-SS15	X														Grid location near 2SS11
	2B-SS16	X														Historic sample location 2SS14
	2B-SS17	X														Grid location near 2SS14
	2B-SS18	X														Grid location near 2SS14
	2B-SS19	X														Grid location near 2SS14
	2B-SS20	X														Grid location near 2SS14
	2B-SS21	X														Historic sample location 2SS10
	2B-SS22	X														Grid location near 2SS10
	2B-SS23	X														Grid location near 2SS10
	2B-SS24	X														Grid location near 2SS10
	2B-SS24MS	X														Matrix spike
	2B-SS24MSD	X														Matrix spike duplicate
	2B-SS24D	X														Duplicate
	2B-SS25	X														Grid location near 2SS10

TABLE 3-5
UPLAND AND ESTUARINE WETLAND SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested															
Sample Media/ Type	Sample Identification	Sb, Cu, Pb, Hg, and Zn	Earthworm Toxicity Test	Cu, Pb, Hg, and Zn	Amphipod Toxicity Test	Polychaete Toxicity Test	As, Cd, Cu, Pb, Hg, Se, and Zn	Pb and Hg	Sb, As, Cd, Cu, Pb, Hg, Se, and Zn	AVS/SEM	TOC	Grain Size	pH	Ammonia and Sulfide	Percent Lipids	Comments	
Surface Soil Samples (Solid)	SWMU 2 (continued):																
	2B-SS26	X														Historic sample location 2SB05	
	2B-SS27	X														Grid location near 2SB05	
	2B-SS28	X														Grid location near 2SB05	
	2B-SS29	X														Grid location near 2SB05	
	2B-SS30	X														Grid location near 2SB05	
	2B-SS31	X	X								X	X	X			Historic sample location 2SS05	
	2B-SS32	X														Grid location near 2SS05	
	2B-SS33	X	X								X	X	X			Grid location near 2SS05	
	2B-SS34	X	X								X	X	X			Grid location near 2SS05	
	2B-SS34D	X														Duplicate	
	2B-SS35	X														Grid location near 2SS05	
	2B-SS36	X														Historic sample location 2SS02	
	2B-SS37	X														Grid location near 2SS02	
	2B-SS38	X														Grid location near 2SS02	
	2B-SS39	X														Grid location near 2SS02	
	2B-SS40	X														Grid location near 2SS02	
	2B-SS41	X	X									X	X	X			Historic sample location 2SB03
	2B-SS42	X															Grid location near 2SB03
	2B-SS43	X															Grid location near 2SB03
	2B-SS44	X	X									X	X	X			Grid location near 2SB03
	2B-SS44D	X															Duplicate
	2B-SS45	X															Grid location near 2SB03
	2B-SS46	X															Historic sample location 2SB01
	2B-SS47	X															Grid location near 2SB01
	2B-SS48	X															Grid location near 2SB01
	2B-SS49	X	X									X	X	X			Grid location near 2SB01
	2B-SS50	X															Grid location near 2SB01
		Upland Reference Area No. 2:															
		2B-REF-SS01	X														
		2B-REF-SS02	X														
		2B-REF-SS03	X														

TABLE 3-5
UPLAND AND ESTUARINE WETLAND SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested														
Sample Media/ Type	Sample Identification	Sb, Cu, Pb, Hg, and Zn	Earthworm Toxicity Test	Cu, Pb, Hg, and Zn	Amphipod Toxicity Test	Polychaete Toxicity Test	As, Cd, Cu, Pb, Hg, Se, and Zn	Pb and Hg	Sb, As, Cd, Cu, Pb, Hg, Se, and Zn	AVS/SEM	TOC	Grain Size	pH	Ammonia and Sulfide	Percent Lipids	Comments
Surface Soil Samples (Solid)	Upland Reference Area No. 2 (continued):															
	2B-REF-SS04	X	X								X	X	X			
	2B-REF-SS04MS															Matrix spike
	2B-REF-SS04MSD															Matrix spike duplicate
	2B-REF-SS04D	X														Duplicate
	2B-REF-SS05	X	X								X	X	X			
2B-REF-SS06	X															
Subsurface Soil (Solid)	SWMU 2:															
	2B-SB01-01	X														Historic sample location 2SS03/06SS103
	2B-SB02-01	X														Grid location near 2SS03/06SS103
	2B-SB04-01	X	X								X	X	X			Grid location near 2SS03/06SS103
	2B-SB04-01MS	X														Matrix spike
	2B-SB04-01MSD	X														Matrix Spike duplicate
	2B-SB04-01D	X														Duplicate
	2B-SB06-01	X														Historic sample location 06SS101
	2B-SB07-01	X														Grid location near 06SS101
	2B-SB08-01	X														Grid location near 06SS101
	2B-SB09-01	X														Grid location near 06SS101
	SB-SB10-01	X														Grid location near 06SS101
	Upland Reference Area No. 2:															
	2B-REF-SB01-01	X	X								X	X	X			
	2B-REF-SB02-01	X														
	2B-REF-SB03-01	X														
	2B-REF-SB04-01	X														
	2B-REF-SB04-01D	X														Duplicate
2B-REF-SB05-01	X															
2B-REF-SB06-01	X															
Earthworm Tissue (Solid)	SWMU 2:															
	2B-SS04	X													X	
	2B-SS05	X													X	
	2B-SS10	X													X	
	2B-SS13	X													X	
	2B-SS14	X													X	

TABLE 3-5
UPLAND AND ESTUARINE WETLAND SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested														
Sample Media/ Type	Sample Identification	Sb, Cu, Pb, Hg, and Zn	Earthworm Toxicity Test	Cu, Pb, Hg, and Zn	Amphipod Toxicity Test	Polychaete Toxicity Test	As, Cd, Cu, Pb, Hg, Se, and Zn	Pb and Hg	Sb, As, Cd, Cu, Pb, Hg, Se, and Zn	AVS/SEM	TOC	Grain Size	pH	Ammonia and Sulfide	Percent Lipids	Comments
Earthworm Tissue (Solid)	SWMU 2 (continued):															
	2B-SS31	X													X	
	2B-SS33	X													X	
	2B-SS34	X													X	
	2B-SS41	X													X	
	2B-SS44	X													X	
	2B-SS49	X													X	
	Upland Reference Area No. 2:															
	2B-REF-SS04	X													X	
	2B-REF-SS05	X													X	
2B-REF-SB01-01	X													X		
Estuarine Wetland Sediment (Solid)	SWMU 2:															
	2B-EWSD01			X												
	2B-EWSD02			X												
	2B-EWSD03			X												
	2B-EWSD04			X	X	X				X	X	X	X	X		
	2B-EWSD04MS			X												Matrix spike
	2B-EWSD04MSD			X												Matrix spike duplicate
	2B-EWSD04D			X												Duplicate
	2B-EWSD05			X												
	2B-EWSD06			X												
	2B-EWSD07			X												
	2B-EWSD08			X												
	2B-EWSD09			X	X	X				X	X	X	X	X		
	2B-EWSD10			X												
	2B-EWSD11			X												
	2B-EWSD12			X	X	X				X	X	X	X	X		
	2B-EWSD13			X												
	2B-EWSD14			X												
	2B-EWSD14D			X												Duplicate
	2B-EWSD15			X						X	X	X	X	X		
2B-EWSD16			X	X	X				X	X	X	X	X			
2B-EWSD18			X	X	X				X	X	X	X	X			

TABLE 3-5
UPLAND AND ESTUARINE WETLAND SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested															
Sample Media/ Type	Sample Identification	Sb, Cu, Pb, Hg, and Zn	Earthworm Toxicity Test	Cu, Pb, Hg, and Zn	Amphipod Toxicity Test	Polychaete Toxicity Test	As, Cd, Cu, Pb, Hg, Se, and Zn	Pb and Hg	Sb, As, Cd, Cu, Pb, Hg, Se, and Zn	AVS/SEM	TOC	Grain Size	pH	Ammonia and Sulfide	Percent Lipids	Comments	
Estuarine Wetland Sediment (Solid)	SWMU 2 (continued):																
	2B-EWSD19				X												
	2B-EWSD20				X	X	X			X	X	X	X	X			
	2B-EWSD21				X												
	2B-EWSD22				X												
	2B-EWSD23				X												
	2B-EWSD24				X	X	X			X	X	X	X	X			
	Estuarine Wetland Reference Area:																
	2B-REF-EWSD01				X	X	X			X	X	X	X	X			
	2B-REF-EWSD02				X	X	X			X	X	X	X	X			
	2B-REF-EWSD03				X												
	2B-REF-EWSD04				X												
	2B-REF-EWSD04MS				X												
	2B-REF-EWSD04MSD				X												
2B-REF-EWSD04D				X													
2B-REF-EWSD05				X													
2B-REF-EWSD06				X													
Fiddler Crab Tissue (solid)	SWMU 2:																
	2B-FC01							X							X	Tissue collected from Section No. 1	
	2B-FC02							X							X	Tissue collected from Section No. 1	
	2B-FC03							X							X	Tissue collected from Section No. 2	
	2B-FC04							X							X	Tissue collected from Section No. 2	
	2B-FC05							X							X	Tissue collected from Section No. 3	
	2B-FC06							X							X	Tissue collected from Section No. 3	
	2B-FC07							X							X	Tissue collected from Section No. 4	
	2B-FC08							X							X	Tissue collected from Section No. 4	
	Estuarine Wetland Reference Area:																
	2B-REF-FC01								X							X	
	2B-REF-FC02								X							X	
2B-REF-FC03								X							X		
2B-REF-FC04								X							X		

TABLE 3-5
UPLAND AND ESTUARINE WETLAND SAMPLING AND ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Analyses Requested														
Sample Media/ Type	Sample Identification	Sb, Cu, Pb, Hg, and Zn	Earthworm Toxicity Test	Cu, Pb, Hg, and Zn	Amphipod Toxicity Test	Polychaete Toxicity Test	As, Cd, Cu, Pb, Hg, Se, and Zn	Pb and Hg	Sb, As, Cd, Cu, Pb, Hg, Se, and Zn	AVS/SEM	TOC	Grain Size	pH	Ammonia and Sulfide	Percent Lipids	Comments
Turtle Grass Tissue (Solid)	SWMU 2:															
	2B-SG01-AG						X									Above ground tissue sample
	2B-SG01-WP						X									Whole plant tissue sample
	2B-SGO2-AG						X									Above ground tissue sample
	2B-SGO2-WP						X									Whole plant tissue sample
	2B-SGO3-AG						X									Above ground tissue sample
Ensenada Honda Sediment (Solid)	2B-SGO3-WP						X									Whole plant tissue sample
	SWMU 2:															
	2B-OWSD01						X				X	X				Co-located with 2B-SG01-AG and 2B-SG01-WP
	2B-OWSD02						X				X	X				Co-located with 2B-SG02-AG and 2B-SG02-WP
	2B-OWSD02D						X				X	X				Duplicate
QA/QC Samples (Aqueous)	2B-OWSD03						X				X	X				Co-located with 2B-SG03-AG and 2B-SG03-WP
	Equipment Rinsate Blanks:															
	2B-ER01 ⁽¹⁾								X							Stainless steel spoon
	2B-ER02 ⁽²⁾								X							Stainless steel bucket auger
	2B-ER03 ⁽³⁾								X							Aluminum pan
	Field Blanks:															
	2B-FB01								X							Laboratory-grade deionized water
2B-FB02								X							Potable water	

Notes:

As = Arsenic
Cd = Cadmium
Cu = Copper
Pb = Lead
Hg = Mercury
Se = Selenium

Zn = Zinc
AVS/SEM = Acid Volatile Sulfide/Simultaneously Extracted Metals
QA/QC = Quality Assurance/Quality Control
SWMU = Solid Waste Management Unit
TOC = Total Organic Carbon

- ⁽¹⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused stainless steel spoon.
⁽²⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused bucket auger.
⁽³⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused aluminum pan.

TABLE 3-6
ANALYTICAL METHODOLOGY: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Medium/Type	Analyte	Analytical Method	Preparation Method
Soil Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Grain size	ASTM D-422	NA
	Total organic carbon	Lloyd Kahn	NA
	pH	SW-846 9045C	NA
Earthworm Tissue Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Percent lipids	STL-TALL SOP	NA
Estuarine Wetland Sediment Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Acid volatile sulfide	EPA AVS	STL-SAV SOP
	Simultaneously extracted metals	EPA SEM	EPA AVSSEM
	Ammonia	MCAWW 350.1	EPA 3-154
	Sulfide	SW-846 9034	SW-846 9030B
	Total organic carbon	Lloyd Kahn	NA
	pH	SW-846 9045C	NA
Fiddler Crab Tissue Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Percent Lipids	STL-TALL SOP	NA
Open Water Sediment Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Grain size	ASTM D-422	NA
	Total organic carbon	Lloyd Kahn	NA
Turtle Grass Tissue Samples (Solid)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3050B
	Mercury	SW-846 7471A	SW-846 7471A
	Percent Moisture	EPA Percent Moisture	NA
QA/QC Samples ⁽¹⁾ (Aqueous)	Appendix IX metals (except mercury)	SW-846 6020	SW-846 3005A
	Mercury	SW-846 7470A	SW-846 7470A

Notes:

AVS = Acid Volatile Sulfide

SEM = Simultaneously Extracted Metals

QA/QC = Quality Assurance/Quality Control

ASTM = American Society for Testing and Materials

SW-846 = Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods

EPA = Environmental Protection Agency

STL-SAV = Severn Trent Laboratories, Inc., Savannah, Georgia Facility

STL-TALL = Severn Trent Laboratories, Inc., Tallahassee, Florida Facility

MCAWW = Methods for Chemical Analysis of Wastes

SOP = Standard Operating Procedure

NA = Not Applicable

⁽¹⁾ The aqueous QA/QC samples consist of equipment rinsate and field blanks.

TABLE 3-7
OPEN WATER REFERENCE AREA NO. 2 TURTLE GRASS AND SEDIMENT SAMPLING AND
ANALYTICAL PROGRAM: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Media/Type	Sample Identification ⁽¹⁾	Analyses Requested		Comment
		TOC and Grain Size	As, Cd, Cu, Hg, Pb, Se, and Zn	
Turtle Grass Tissue Samples (Solid)	REF2-VEG-AB01		X	Above ground tissue sample
	REF2-VEG-WB01		X	Whole-plant tissue sample
	REF2-VEG-AB02		X	Above ground tissue sample
	REF2-VEG-WB02		X	Whole-plant tissue sample
	REF2-VEG-AB03		X	Above ground tissue sample
	REF2-VEG-WB03		X	Whole plant tissue sample
Co-located Sediment Samples (Solid)	REF2-VEG-SED01	X	X	Co-located with REF2-VEG-AB01 and REF2-VEG-WB01
	REF2-VEG-SED02	X	X	Co-located with REF2-VEG-AB02 and REF2-VEG-WB02
	REF2-VEG-SED03	X	X	Co-located with REF2-VEG-AB03 and REF2-VEG-WB03
QA/QC Samples (Aqueous)	Field Blanks: 45B-FB01		X	Laboratory-grade deionized water

Notes:

As= Arsenic

Cd = Cadmium

Cu = Copper

Pb = Lead

Hg = Mercury

Se = Selenium

Zn = Zinc

QA/QC = Quality Assurance/Quality Control

TOC = Total Organic Carbon

⁽¹⁾ The open water reference area turtle grass tissue and sediment samples, as well as the associated QA/QC sample were collected on January 31, 2007 during the Step 6 BERA field investigation at SWMU 45.

TABLE 3-8
DATA QUALIFIER DEFINITIONS
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample Data Qualifiers:

- [none] The analyte was positively detected.
- J The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit
- U The analyte was analyzed for, but not detected at the reported sample quantitation limit
- UJ The analyte was analyzed for, but not detected; The reported sample quantitation limit is qualified as estimated

TABLE 4-1
SWMU 2 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2V-SB01	2V-SB02	2V-SB03	2V-SB04	2V-SB05	2V-SB06
Sample ID	2V-SS01	2V-SS02	2V-SS03	2V-SS04	2V-SS05	2V-SS06
Sampling Date	2/27/2007	2/27/2007	2/27/2007	2/27/2007	2/27/2007	2/27/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
General Chemistry						
pH	7.7	7.33	7.36	7.67	7.48	8.26
TOC (mg/kg)	24,000	43,000	56,000	29,000	53,000	26,000
Grain Size (percent)						
Gravel	5.9	4.1	47.3	72	23.4	56.5
Sand	14.8	22.0	26.8	11.8	29.6	10.4
Coarse Sand	6.5	4.0	7.5	4.2	7.3	3.2
Medium Sand	2.8	7.7	10.4	4.5	11.5	3.4
Fine Sand	5.5	10.2	8.8	3.1	10.8	3.8
Silt	41.1	34.5	14.5	4.6	20.1	7.0
Clay	38.2	39.4	11.4	11.6	26.9	26.1
Soil Textural Classification ⁽¹⁾	Silty Clay Loam	Clay Loam	Silt loam	Silt Loam	Loam	Silt Loam

Notes:

TOC = Total Organic Carbon
mg/kg = milligram per kilogram
bgs = below ground surface

⁽¹⁾ Soil textural classifications were identified using a computer program (Gerakis and Baer, 1999).

Table References

Gerakis, A. and B. Baer. 1999. A Computer Program for Soil Textural Classification. Soil. Sci. Soc. Am. J. 63:807-808.

TABLE 4-2
SWMU 2 SUBSURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2V-SB01	2V-SB02	2V-SB03	2V-SB04	2V-SB05	2V-SB06
Sample ID	2V-SB01	2V-SB02	2V-SB03	2V-SB04	2V-SB05	2V-SB06
Sampling Date	2/27/2007	2/27/2007	2/27/2007	2/27/2007	2/27/2007	2/27/2007
Depth Range (feet bgs)	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0
General Chemistry						
pH	9.34	8.55	9.37	8.06	8.53	8.81
TOC (mg/kg)	26,000	8,100	9,800	17,000	15,000	7,400
Grain Size (percent)						
Gravel	65.4	1.9	17	4.8	25.3	20.4
Sand	24.8	13.1	29	28.0	24.0	19.7
Coarse Sand	6.7	1.8	7.5	6.9	5.8	5.7
Medium Sand	9.3	4.8	11.1	10.0	8.6	7.3
Fine Sand	8.8	6.5	10.4	11.2	9.6	6.6
Silt	4.1	23.7	26.1	29.1	22.6	11.1
Clay	5.7	61.3	27.9	38.0	28.2	48.8
Silt+Clay	9.8	85	54	67.1	50.8	59.9
Soil Textural Classification ⁽¹⁾	Silt Loam	Clay	Clay Loam	Clay Loam	Clay Loam	Clay

Notes:

TOC = Total Organic Carbon
mg/kg = milligram per kilogram
bgs = below ground surface

⁽¹⁾ Soil textural classifications were identified using a computer program (Gerakis and Baer, 1999).

Table References

Gerakis, A. and B. Baer. 1999. A Computer Program for Soil Textural Classification. Soil. Sci. Soc. Am. J. 63:807-808.

TABLE 4-3
UPLAND REFERENCE AREA NO. 1 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SB01	REF-SB01	REF-SB02	REF-SB03	REF-SB03	REF-SB04
Sample ID	REF-SS01	REF-SS01D	REF-SS02	REF-SS03	REF-SS03D	REF-SS04
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
PAHs (ug/kg)						
1-Methylnaphthalene	1.3 U	1.3 U	2.6 U	NA	NA	NA
2-Methylnaphthalene	1.1 U	1.1 U	2.3 U	NA	NA	NA
Acenaphthene	1.2 U	1.2 U	2.4 U	NA	NA	NA
Acenaphthylene	1.2 U	1.1 U	2.3 U	NA	NA	NA
Anthracene	1.2 U	1.2 U	2.4 U	NA	NA	NA
Benzo(a)anthracene	1.2 U	1.2 U	2.4 U	NA	NA	NA
Benzo(a)pyrene	0.98 U	0.97 U	2 U	NA	NA	NA
Benzo(b)fluoranthene	1.3 U	1.3 U	3.9 J	NA	NA	NA
Benzo(g,h,i)perylene	1.2 U	1.2 U	2.4 U	NA	NA	NA
Benzo(k)fluoranthene	1 U	1 U	2 U	NA	NA	NA
Chrysene	1.1 U	1.1 U	2.2 U	NA	NA	NA
Dibenz(a,h)anthracene	1.7 U	1.6 U	3.3 U	NA	NA	NA
Fluoranthene	1.3 U	1.3 U	3 J	NA	NA	NA
Fluorene	1.4 U	1.4 U	2.8 U	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.9 U	1.9 U	3.8 U	NA	NA	NA
Naphthalene	1.4 U	1.4 U	2.8 U	NA	NA	NA
Phenanthrene	1.5 U	1.5 U	3.1 U	NA	NA	NA
Pyrene	1.4 U	1.4 U	2.8 J	NA	NA	NA
LMW PAHs ⁽¹⁾	11.6	11.5	23.7	NA	NA	NA
HMW PAHs ⁽²⁾	11.8	11.7	24.8	NA	NA	NA
Pesticides (ug/kg)						
4,4'-DDD	0.35 U	0.35 U	0.71 U	NA	NA	NA
4,4'-DDE	0.35 U	0.35 U	0.71 U	NA	NA	NA
4,4'-DDT	0.45 J	0.87 J	0.64 U	NA	NA	NA
Aldrin	0.16 U	0.16 U	0.33 U	NA	NA	NA
alpha-BHC	0.61 U	0.61 U	1.2 U	NA	NA	NA
beta-BHC	0.55 U	0.55 U	1.1 U	NA	NA	NA
Chlordane (technical)	3.5 U	3.5 U	7.1 U	NA	NA	NA
delta-BHC	0.27 U	0.27 U	0.55 U	NA	NA	NA

TABLE 4-3
UPLAND REFERENCE AREA NO. 1 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS01	REF-SS01	REF-SS02	REF-SS03	REF-SS03	REF-SS04
Sample ID	REF-SS01	REF-SS01D	REF-SS02	REF-SS03	REF-SS03D	REF-SS04
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Dieldrin	0.41 U	0.41 U	0.83 U	NA	NA	NA
Endosulfan I	0.19 U	0.19 U	0.38 U	NA	NA	NA
Endosulfan II	0.32 U	0.32 U	0.64 U	NA	NA	NA
Endosulfan sulfate	0.44 U	0.43 U	0.88 U	NA	NA	NA
Endrin	0.38 U	0.38 U	0.76 U	NA	NA	NA
Endrin aldehyde	0.77 U	0.76 U	1.5 U	NA	NA	NA
Endrin ketone	0.38 U	0.38 U	0.76 U	NA	NA	NA
gamma-BHC (Lindane)	0.16 U	0.16 U	0.33 U	NA	NA	NA
Heptachlor	0.38 U	0.38 U	0.76 U	NA	NA	NA
Heptachlor epoxide	0.25 U	0.25 U	0.5 U	NA	NA	NA
Isodrin	0.39 U	0.39 U	0.78 U	NA	NA	NA
Kepone	7.9 U	7.9 U	16 U	NA	NA	NA
Methoxychlor	0.55 U	0.55 U	1.1 U	NA	NA	NA
Toxaphene	14 U	14 U	28 U	NA	NA	NA
Metals (mg/kg)						
Antimony	0.45 U	0.42 U	0.87 UJ	0.39 U	0.39 U	0.42 U
Arsenic	4.6	4.8	4.6 J	NA	NA	NA
Barium	18 J	18 J	17 J	NA	NA	NA
Beryllium	0.067 U	0.063 U	0.13 UJ	NA	NA	NA
Cadmium	0.078 J	0.079 J	0.087 UJ	NA	NA	NA
Chromium	8.6	9.2	4.9 J	NA	NA	NA
Cobalt	3.5	3.5	2.4 J	NA	NA	NA
Copper	17	18	10 J	9.5	6.5	54
Lead	6.1	8.3	5.8 J	2.4	1.7	7.1
Mercury	0.039	0.039	0.068 J	0.021	0.015 J	0.062
Nickel	3.7	3.7	2.3 J	NA	NA	NA
Selenium	0.36 J	0.36 J	0.44 UJ	NA	NA	NA
Silver	0.11 U	0.11 U	0.22 UJ	NA	NA	NA
Thallium	0.11 U	0.11 U	0.22 UJ	NA	NA	NA
Tin	11 U	11 U	22 UJ	NA	NA	NA
Vanadium	27	27	17 J	NA	NA	NA
Zinc	18	17	16 J	10	7.3 J	60

TABLE 4-3
UPLAND REFERENCE AREA NO. 1 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS01	REF-SS01	REF-SS02	REF-SS03	REF-SS03	REF-SS04
Sample ID	REF-SS01	REF-SS01D	REF-SS02	REF-SS03	REF-SS03D	REF-SS04
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
General Chemistry						
pH	7.86	NA	7.49	8.4	NA	7.77
TOC (mg/kg)	71,000	NA	38,000	9,400	NA	38,000
Grain Size (percent)						
Gravel	7.1	NA	2.2	29.5	NA	13.8
Sand	62.4	NA	87.7	63	NA	28.1
Coarse Sand	3.6	NA	2.4	4.3	NA	3.7
Medium Sand	18.0	NA	19.8	19.3	NA	7.0
Fine Sand	40.8	NA	65.5	39.4	NA	9.1
Silt	21.8	NA	5.1	4.1	NA	30.4
Clay	8.7	NA	5.0	3.4	NA	27.7
Soil Textural Classification ⁽³⁾	Sandy loam	NA	Sand	Sandy Loam	NA	Clay Loam

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

UJ = The analyte was analyzed for, but not detected; The reported sample quantitation limit is qualified as estimated

PAH = Polycyclic Aromatic Hydrocarbon

TOC = Total Organic Carbon

ug/kg = microgram per kilogram

mg/kg = milligram per kilogram

LMW = Low Molecular Weight

HMW = High Molecular Weight

NA = Not Analyzed

bgs = below ground surface

TABLE 4-3
UPLAND REFERENCE AREA NO. 1 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

- ⁽¹⁾ Low molecular weight (LMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of fewer than four rings. The LMW PAH compounds analyzed for in SWMU 2 soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene naphthalene, and phenanthrene. For a given sample, the LWM PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected LMW PAHs).
- ⁽²⁾ High molecular weight (HMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of four or more rings. The HMW PAH compounds analyzed for in SWMU 2 soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene dibenz(a,h)anthracene, pyrene, and indeno(1,2,3-cd)pyrene. For a given sample, the high molecular weight PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected HMW PAHs).
- ⁽³⁾ Soil textural classifications were identified using a computer program (Gerakis and Baer, 1999).

Table References:

Gerakis, A. and B. Baer. 1999. A Computer Program for Soil Textural Classification. Soil. Sci. Soc. Am. J. 63:807-808.

USEPA. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

TABLE 4-4
UPLAND REFERENCE AREA NO. 2 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION
OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SB05	REF-SB06	REF-SB07	REF-SB08
Sample ID	REF-SS05	REF-SS06	REF-SS07	REF-SS08
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
PAHs (ug/kg)				
1-Methylnaphthalene	1.5 U	1.5 U	NA	NA
2-Methylnaphthalene	1.3 U	1.3 U	NA	NA
Acenaphthene	1.4 U	1.4 U	NA	NA
Acenaphthylene	1.4 U	1.3 U	NA	NA
Anthracene	1.4 U	1.4 U	NA	NA
Benzo(a)anthracene	3.1 J	3.6 J	NA	NA
Benzo(a)pyrene	2.7 J	3 J	NA	NA
Benzo(b)fluoranthene	3.9 J	4.8 J	NA	NA
Benzo(g,h,i)perylene	1.7 J	2.3 J	NA	NA
Benzo(k)fluoranthene	1.7 J	1.7 J	NA	NA
Chrysene	3 J	3.4 J	NA	NA
Dibenz(a,h)anthracene	1.9 U	1.9 U	NA	NA
Fluoranthene	5.5 J	5.7 J	NA	NA
Fluorene	1.7 U	1.6 U	NA	NA
Indeno(1,2,3-cd)pyrene	2.2 U	2.2 U	NA	NA
Naphthalene	1.7 U	1.6 U	NA	NA
Phenanthrene	2.1 J	2.3 J	NA	NA
Pyrene	4.5 J	4.9 J	NA	NA
LMW PAHs ⁽¹⁾	18	18.1	NA	NA
HMW PAHs ⁽²⁾	24.7	27.8	NA	NA
Pesticides (ug/kg)				
4,4'-DDD	0.62 J	0.41 U	NA	NA
4,4'-DDE	0.41 U	0.41 U	NA	NA
4,4'-DDT	5.5 J	0.37 U	NA	NA
Aldrin	0.19 U	0.19 U	NA	NA
alpha-BHC	0.72 U	0.71 U	NA	NA
beta-BHC	0.65 U	0.64 U	NA	NA
Chlordane (technical)	4.1 U	4.1 U	NA	NA
delta-BHC	0.32 U	0.31 U	NA	NA
Dieldrin	0.48 U	0.48 U	NA	NA
Endosulfan I	0.22 U	0.22 U	NA	NA
Endosulfan II	0.37 U	0.37 U	NA	NA
Endosulfan sulfate	0.51 U	0.51 U	NA	NA
Endrin	0.44 U	0.44 U	NA	NA
Endrin aldehyde	0.89 U	0.89 U	NA	NA
Endrin ketone	0.44 U	0.44 U	NA	NA
gamma-BHC (Lindane)	0.19 U	0.19 U	NA	NA
Heptachlor	0.44 U	0.44 U	NA	NA
Heptachlor epoxide	0.29 U	0.29 U	NA	NA
Isodrin	0.45 U	0.45 U	NA	NA
Kepone	9.2 U	9.2 U	NA	NA
Methoxychlor	0.65 U	0.64 U	NA	NA
Toxaphene	17 U	16 U	NA	NA

TABLE 4-4
UPLAND REFERENCE AREA NO. 2 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION
OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS05	REF-SS06	REF-SS07	REF-SS08
Sample ID	REF-SS05	REF-SS06	REF-SS07	REF-SS08
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)				
Antimony	0.52 U	0.5 U	0.45 U	0.46 U
Arsenic	3.3	1.9	NA	NA
Barium	100 J	110 J	NA	NA
Beryllium	0.32	0.25	NA	NA
Cadmium	0.15 J	0.11 J	NA	NA
Chromium	35	27	NA	NA
Cobalt	33	31	NA	NA
Copper	100	110	44	65
Lead	5.7	6	12	8.9
Mercury	0.032	0.016 J	0.057	0.026
Nickel	28	19	NA	NA
Selenium	0.67 J	0.48 J	NA	NA
Silver	0.13 U	0.13 U	NA	NA
Thallium	0.13 U	0.13 U	NA	NA
Tin	13 U	13 U	NA	NA
Vanadium	180	180	NA	NA
Zinc	65	65	54	59
General Chemistry				
pH	8.52	8.58	6.47	7.11
TOC (mg/kg)	20,000	9,800	26,000	21,000
Grain Size (percent)				
Gravel	10.4	0.0	0.9	2.7
Sand	19.5	21.7	20.8	12.5
Coarse Sand	3.4	0.2	3.2	3.0
Medium Sand	7	3.5	8.8	3.6
Fine Sand	9.1	18.0	8.9	5.8
Silt	31.5	44.3	29.1	29.4
Clay	35.0	34.0	49.2	55.5
Soil Textural Classification ⁽³⁾	Silty Clay Loam	Clay Loam	Clay	Clay

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

PAH = Polycyclic Aromatic Hydrocarbon
TOC = Total Organic Carbon
ug/kg = microgram per kilogram
mg/kg = milligram per kilogram

LMW = Low Molecular Weight
HMW = High Molecular Weight
NA = Not Analyzed
bgs = below ground surface

TABLE 4-4
UPLAND REFERENCE AREA NO. 2 SURFACE SOIL ANALYTICAL RESULTS: VERIFICATION
OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

- (1) Low molecular weight (LMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of fewer than four rings. The LMW PAH compounds analyzed for in SWMU 2 soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. For a given sample, the LWM PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected LMW PAHs).
- (2) High molecular weight (HMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of four or more rings. The HMW PAH compounds analyzed for in SWMU 2 soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, pyrene, and indeno(1,2,3-cd)pyrene. For a given sample, the high molecular weight PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected HMW PAHs).
- (3) Soil textural classifications were identified using a computer program (Gerakis and Baer, 1999).

Table References:

Gerakis, A. and B. Baer. 1999. A Computer Program for Soil Textural Classification. Soil. Sci. Soc. Am. J. 63:807-808.

USEPA. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

TABLE 4-5
UPLAND REFERENCE AREA NO. 3 SURFACE SOIL ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SB09	REF-SB10	REF-SB11	REF-SB12
Sample ID	REF-SS09	REF-SS10	REF-SS11	REF-SS12
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
PAHs (ug/kg)				
1-Methylnaphthalene	1.3 U	1.4 U	NA	NA
2-Methylnaphthalene	1.2 U	1.2 U	NA	NA
Acenaphthene	1.2 U	1.3 U	NA	NA
Acenaphthylene	1.2 U	1.2 U	NA	NA
Anthracene	1.2 U	1.3 U	NA	NA
Benzo(a)anthracene	1.2 U	1.3 U	NA	NA
Benzo(a)pyrene	1 U	1 U	NA	NA
Benzo(b)fluoranthene	1.3 U	1.4 U	NA	NA
Benzo(g,h,i)perylene	1.2 U	1.3 U	NA	NA
Benzo(k)fluoranthene	1 U	1.1 U	NA	NA
Chrysene	1.1 U	1.2 U	NA	NA
Dibenz(a,h)anthracene	1.7 U	1.8 U	NA	NA
Fluoranthene	1.3 U	1.4 U	NA	NA
Fluorene	1.5 U	1.5 U	NA	NA
Indeno(1,2,3-cd)pyrene	2 U	2 U	NA	NA
Naphthalene	1.5 U	1.5 U	NA	NA
Phenanthrene	1.6 U	1.6 U	NA	NA
Pyrene	1.5 U	1.5 U	NA	NA
LMW PAHs ⁽¹⁾	12	12.4	NA	NA
HMW PAHs ⁽²⁾	12	12.6	NA	NA
Pesticides (ug/kg)				
4,4'-DDD	4 U	0.38 U	NA	NA
4,4'-DDE	4 U	0.38 U	NA	NA
4,4'-DDT	4 U	0.34 U	NA	NA
Aldrin	2.1 U	0.18 U	NA	NA
alpha-BHC	2.1 U	0.66 U	NA	NA
beta-BHC	2.1 U	0.6 U	NA	NA
Chlordane (technical)	21 U	3.8 U	NA	NA
delta-BHC	2.1 U	0.29 U	NA	NA
Dieldrin	4 U	0.44 U	NA	NA
Endosulfan I	2.1 U	0.2 U	NA	NA
Endosulfan II	4 U	0.34 U	NA	NA
Endosulfan sulfate	4 U	0.47 U	NA	NA
Endrin	4 U	0.41 U	NA	NA
Endrin aldehyde	4 U	0.82 U	NA	NA
Endrin ketone	4 U	0.41 U	NA	NA
gamma-BHC (Lindane)	2.1 U	0.18 U	NA	NA
Heptachlor	2.1 U	0.41 U	NA	NA
Heptachlor epoxide	2.1 U	0.27 U	NA	NA
Isodrin	4 U	0.42 U	NA	NA
Kepone	210 U	8.5 U	NA	NA
Methoxychlor	21 U	0.6 U	NA	NA
Toxaphene	210 U	15 U	NA	NA

TABLE 4-5
UPLAND REFERENCE AREA NO. 3 SURFACE SOIL ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SS09	REF-SS010	REF-SS011	REF-SS012
Sample ID	REF-SS09	REF-SS010	REF-SS011	REF-SS012
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)				
Antimony	0.45 U	0.46 U	0.42 U	0.44 U
Arsenic	1.1 J	1.1	NA	NA
Barium	170 J	240 J	NA	NA
Beryllium	0.28	0.35	NA	NA
Cadmium	0.074 J	0.095 J	NA	NA
Chromium	58	43	NA	NA
Cobalt	30	26	NA	NA
Copper	100	110	72	72
Lead	2.7	3.5	4.8	8.3
Mercury	0.027	0.061	0.044	0.029
Nickel	17	13	NA	NA
Selenium	0.76 J	1.2	NA	NA
Silver	0.11 U	0.11 U	NA	NA
Thallium	0.11 U	0.11 U	NA	NA
Tin	11 U	11 U	NA	NA
Vanadium	260	230	NA	NA
Zinc	33	43	120	61
General Chemistry				
pH	8.55	6.07	7.91	7.95
TOC (mg/kg)	13,000	34,000	17,000	13,000
Grain Size (percent)				
Gravel	0.0	0.8	27	13.1
Sand	37.5	21.9	28.7	23.2
Coarse Sand	0.6	0.9	8.2	5.4
Medium Sand	7.0	2.8	7.6	7.0
Fine Sand	29.9	18.2	12.9	10.7
Silt	22.8	34.5	17.3	22.8
Clay	39.6	42.7	27	40.9
Soil Textural Classification ⁽³⁾	Clay Loam	Clay	Loam/Clay Loam	Clay

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

PAH = Polycyclic Aromatic Hydrocarbon
TOC = Total Organic Carbon
ug/kg = microgram per kilogram
mg/kg = milligram per kilogram

LMW = Low Molecular Weight
HMW = High Molecular Weight
NA = Not Analyzed
bgs = below ground surface

TABLE 4-5
UPLAND REFERENCE AREA NO. 3 SURFACE SOIL ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

- ⁽¹⁾ Low molecular weight (LMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of fewer than four rings. The LMW PAH compounds analyzed for in SWMU 2 soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. For a given sample, the LWM PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected LMW PAHs).
- ⁽²⁾ High molecular weight (HMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of four or more rings. The HMW PAH compounds analyzed for in SWMU 2 soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, pyrene, and indeno(1,2,3-cd)pyrene. For a given sample, the high molecular weight PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected HMW PAHs).
- ⁽³⁾ Soil textural classifications were identified using a computer program (Gerakis and Baer, 1999).

Table References:

Gerakis, A. and B. Baer. 1999. A Computer Program for Soil Textural Classification. Soil. Sci. Soc. Am. J. 63:807-808.

USEPA. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

TABLE 4-6
UPLAND REFERENCE AREA NO. 1 SUBSURFACE SOIL ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SB01	REF-SB02	REF-SB03	REF-SB04
Sample ID	REF-SB01	REF-SB02	REF-SB03	REF-SB04
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	1.0-2.0	0.0-1.0	0.0-1.0	0.0-1.0
PAHs (ug/kg)				
1-Methylnaphthalene	1.2 U	1.2 U	NA	NA
2-Methylnaphthalene	1 U	1.1 U	NA	NA
Acenaphthene	1.1 U	1.1 U	NA	NA
Acenaphthylene	1 U	1.1 U	NA	NA
Anthracene	1.1 U	1.1 U	NA	NA
Benzo(a)anthracene	1.1 U	1.1 U	NA	NA
Benzo(a)pyrene	0.88 U	0.93 U	NA	NA
Benzo(b)fluoranthene	1.2 U	1.2 U	NA	NA
Benzo(g,h,i)perylene	1.1 U	1.1 U	NA	NA
Benzo(k)fluoranthene	0.9 U	0.95 U	NA	NA
Chrysene	0.98 U	1 U	NA	NA
Dibenz(a,h)anthracene	1.5 U	1.6 U	NA	NA
Fluoranthene	1.2 U	1.2 U	NA	NA
Fluorene	1.3 U	1.3 U	NA	NA
Indeno(1,2,3-cd)pyrene	1.7 U	1.8 U	NA	NA
Naphthalene	1.3 U	1.3 U	NA	NA
Phenanthrene	1.4 U	1.5 U	NA	NA
Pyrene	1.3 U	1.3 U	NA	NA
LMW PAHs ⁽¹⁾	10.6	10.9	NA	NA
HMW PAHs ⁽²⁾	10.7	11.0	NA	NA
Pesticides (ug/kg)				
4,4'-DDD	0.32 U	3.7 U	NA	NA
4,4'-DDE	0.32 U	3.7 U	NA	NA
4,4'-DDT	1.5 J	4.1	NA	NA
Aldrin	0.15 U	1.9 U	NA	NA
alpha-BHC	0.55 U	1.9 U	NA	NA
beta-BHC	0.5 U	1.9 U	NA	NA
Chlordane (technical)	3.2 U	19 U	NA	NA
delta-BHC	0.24 U	1.9 U	NA	NA
Dieldrin	0.37 U	3.7 U	NA	NA
Endosulfan I	0.17 U	1.9 U	NA	NA
Endosulfan II	0.28 U	3.7 U	NA	NA
Endosulfan sulfate	0.39 U	3.7 U	NA	NA
Endrin	0.34 U	3.7 U	NA	NA
Endrin aldehyde	0.69 U	3.7 U	NA	NA
Endrin ketone	0.34 U	3.7 U	NA	NA
gamma-BHC (Lindane)	0.15 U	1.9 U	NA	NA
Heptachlor	0.34 U	1.9 U	NA	NA
Heptachlor epoxide	0.22 U	1.9 U	NA	NA
Isodrin	0.35 U	3.7 U	NA	NA
Kepone	7.1 U	190 U	NA	NA
Methoxychlor	0.5 U	19 U	NA	NA
Toxaphene	13 U	190 U	NA	NA

TABLE 4-6
UPLAND REFERENCE AREA NO. 1 SUBSURFACE SOIL ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SB01	REF-SB02	REF-SB03	REF-SB04
Sample ID	REF-SB01	REF-SB02	REF-SB03	REF-SB04
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	1.0-2.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)				
Antimony	0.39 U	0.41 U	0.39 U	0.47 U
Arsenic	2.9	4.5	NA	NA
Barium	13 J	11 J	NA	NA
Beryllium	0.065 J	0.061 U	NA	NA
Cadmium	0.058 J	0.041 U	NA	NA
Chromium	6.8 J	4 J	NA	NA
Cobalt	4.1	1.8	NA	NA
Copper	23 J	6.5 J	12	58 J
Lead	2.2	1.6	2.6	1.3
Mercury	0.014 J	0.023	0.024	0.039
Nickel	4	1.7	NA	NA
Selenium	0.19 U	0.21 J	NA	NA
Silver	0.097 U	0.1 U	NA	NA
Thallium	0.097 U	0.1 U	NA	NA
Tin	9.7 U	10 U	NA	NA
Vanadium	38 J	15 J	NA	NA
Zinc	14 J	5.7 J	12	44
General Chemistry				
pH	8.06	7.88	7.92	7.93
TOC (mg/kg)	45,000	36,000	53,000	10,000
Grain Size (percent)				
Gravel	51.2	11.4	38.1	1.3
Sand	41.8	81.5	31.5	10.2
Coarse Sand	13.3	3.7	5.9	1.8
Medium Sand	16.3	26.1	9.5	2.8
Fine Sand	12.1	51.7	16.1	5.6
Silt	3.2	2.4	14	23
Clay	3.8	4.7	16.4	65.6
Soil Textural Classification ⁽³⁾	Silt Loam	Loamy Sand	Silt Loam	Clay

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

PAH = Polycyclic Aromatic Hydrocarbon
TOC = Total Organic Carbon
ug/kg = microgram per kilogram
mg/kg = milligram per kilogram

LMW = Low Molecular Weight
HMW = High Molecular Weight
NA = Not Analyzed
bgs = below ground surface

TABLE 4-6
UPLAND REFERENCE AREA NO. 1 SUBSURFACE SOIL ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

- (1) Low molecular weight (LMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of fewer than four rings. The LMW PAH compounds analyzed for in SWMU 2 soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. For a given sample, the LWM PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected LMW PAHs).
- (2) High molecular weight (HMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of four or more rings. The HMW PAH compounds analyzed for in SWMU 2 soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, pyrene, and indeno(1,2,3-cd)pyrene. For a given sample, the high molecular weight PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected HMW PAHs).
- (3) Soil textural classifications were identified using a computer program (Gerakis and Baer, 1999).

Table References:

Gerakis, A. and B. Baer. 1999. A Computer Program for Soil Textural Classification. Soil. Sci. Soc. Am. J. 63:807-808.

USEPA. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

TABLE 4-7
UPLAND REFERENCE AREA NO. 2 SUBSURFACE SOIL ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SB06	REF-SB07	REF-SB08
Sample ID	REF-SB06	REF-SB07	REF-SB08
Sampling Date	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	1.0-2.0	1.0-2.0	1.0-2.0
PAHs (ug/kg)			
1-Methylnaphthalene	1.5 U	NA	NA
2-Methylnaphthalene	1.3 U	NA	NA
Acenaphthene	1.4 U	NA	NA
Acenaphthylene	1.3 U	NA	NA
Anthracene	1.4 U	NA	NA
Benzo(a)anthracene	1.4 U	NA	NA
Benzo(a)pyrene	1.1 U	NA	NA
Benzo(b)fluoranthene	1.5 U	NA	NA
Benzo(g,h,i)perylene	1.4 U	NA	NA
Benzo(k)fluoranthene	1.2 U	NA	NA
Chrysene	1.3 U	NA	NA
Dibenz(a,h)anthracene	1.9 U	NA	NA
Fluoranthene	1.5 U	NA	NA
Fluorene	1.6 U	NA	NA
Indeno(1,2,3-cd)pyrene	2.2 U	NA	NA
Naphthalene	1.6 U	NA	NA
Phenanthrene	1.8 U	NA	NA
Pyrene	1.6 U	NA	NA
LMW PAHs ⁽¹⁾	13.4	NA	NA
HMW PAHs ⁽²⁾	13.6	NA	NA
Pesticides (ug/kg)			
4,4'-DDD	0.94 J	NA	NA
4,4'-DDE	0.41 U	NA	NA
4,4'-DDT	6.4	NA	NA
Aldrin	0.19 U	NA	NA
alpha-BHC	0.71 U	NA	NA
beta-BHC	0.64 U	NA	NA
Chlordane (technical)	4.1 U	NA	NA
delta-BHC	0.32 U	NA	NA
Dieldrin	0.48 U	NA	NA
Endosulfan I	0.22 U	NA	NA
Endosulfan II	0.37 U	NA	NA
Endosulfan sulfate	0.51 U	NA	NA
Endrin	0.44 U	NA	NA
Endrin aldehyde	0.89 U	NA	NA
Endrin ketone	0.44 U	NA	NA
gamma-BHC (Lindane)	0.19 U	NA	NA
Heptachlor	0.44 U	NA	NA
Heptachlor epoxide	0.29 U	NA	NA
Isodrin	0.45 U	NA	NA
Kepone	9.2 U	NA	NA
Methoxychlor	0.64 U	NA	NA
Toxaphene	16 U	NA	NA

TABLE 4-7
UPLAND REFERENCE AREA NO. 2 SUBSURFACE SOIL ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SB06	REF-SB07	REF-SB08
Sample ID	REF-SB06	REF-SB07	REF-SB08
Sampling Date	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	1.0-2.0	1.0-2.0	1.0-2.0
Metals (mg/kg)			
Antimony	0.51 U	0.46 U	0.45 U
Arsenic	1.9	NA	NA
Barium	120 J	NA	NA
Beryllium	0.39	NA	NA
Cadmium	0.12 J	NA	NA
Chromium	410 J	NA	NA
Cobalt	51	NA	NA
Copper	77 J	44	57
Lead	6.1	13	9
Mercury	0.036	0.043	0.035
Nickel	190	NA	NA
Selenium	0.58 J	NA	NA
Silver	0.13 U	NA	NA
Thallium	0.13 U	NA	NA
Tin	13 U	NA	NA
Vanadium	240 J	NA	NA
Zinc	59 J	58	54
General Chemistry			
pH	8.49	7.42	8.07
TOC (mg/kg)	8,200	6,900	6,700
Grain Size (percent)			
Gravel	36.1	42.7	1.1
Sand	19.8	12.7	15.2
Coarse Sand	5.4	3.3	2.7
Medium Sand	5.3	5.6	5.7
Fine Sand	9.0	3.9	6.8
Silt	12.0	9.6	24.9
Clay	32.2	35.1	58.8
Soil Textural Classification ⁽³⁾	Silty Clay Loam	Silty Clay Loam	Clay

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate;
Also used if a result was measured at a concentration below the Contract Required
Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

PAH = Polycyclic Aromatic Hydrocarbon

TOC = Total Organic Carbon

ug/kg = microgram per kilogram

mg/kg = milligram per kilogram

LMW = Low Molecular Weight

HMW = High Molecular Weight

NA = Not Analyzed

bgs = below ground surface

TABLE 4-7
UPLAND REFERENCE AREA NO. 2 SUBSURFACE SOIL ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

- ⁽¹⁾ Low molecular weight (LMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of fewer than four rings. The LMW PAH compounds analyzed for in SWMU 2 soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. For a given sample, the LWM PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected LMW PAHs).
- ⁽²⁾ High molecular weight (HMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of four or more rings. The HMW PAH compounds analyzed for in SWMU 2 soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, pyrene, and indeno(1,2,3-cd)pyrene. For a given sample, the high molecular weight PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected HMW PAHs).
- ⁽³⁾ Soil textural classifications were identified using a computer program (Gerakis and Baer, 1999).

Table References:

Gerakis, A. and B. Baer. 1999. A Computer Program for Soil Textural Classification. Soil. Sci. Soc. Am. J. 63:807-808.

USEPA. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

TABLE 4-8
UPLAND REFERENCE AREA NO. 3 SUBSURFACE SOIL ANALYTICAL RESULTS: VERIFICATION
OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SB09	REF-SB10	REF-SB11	REF-SB12
Sample ID	REF-SB09	REF-SB10	REF-SB11	REF-SB12
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
PAHs (ug/kg)				
1-Methylnaphthalene	1.5 U	1.3 U	NA	NA
2-Methylnaphthalene	1.3 U	1.2 U	NA	NA
Acenaphthene	1.3 U	1.2 U	NA	NA
Acenaphthylene	1.3 U	1.2 U	NA	NA
Anthracene	1.3 U	1.2 U	NA	NA
Benzo(a)anthracene	1.3 U	1.2 U	NA	NA
Benzo(a)pyrene	1.1 U	0.99 U	NA	NA
Benzo(b)fluoranthene	1.5 U	1.3 U	NA	NA
Benzo(g,h,i)perylene	1.3 U	1.2 U	NA	NA
Benzo(k)fluoranthene	1.1 U	1 U	NA	NA
Chrysene	1.2 U	1.1 U	NA	NA
Dibenz(a,h)anthracene	1.9 U	1.7 U	NA	NA
Fluoranthene	1.5 U	1.3 U	NA	NA
Fluorene	1.6 U	1.4 U	NA	NA
Indeno(1,2,3-cd)pyrene	2.1 U	1.9 U	NA	NA
Naphthalene	1.6 U	1.4 U	NA	NA
Phenanthrene	1.7 U	1.6 U	NA	NA
Pyrene	1.6 U	1.4 U	NA	NA
LMW PAHs ⁽¹⁾	13.1	11.8	NA	NA
HMW PAHs ⁽²⁾	13.1	11.8	NA	NA
Pesticides (ug/kg)				
4,4'-DDD	0.4 U	3.9 U	NA	NA
4,4'-DDE	0.4 U	3.9 U	NA	NA
4,4'-DDT	0.36 U	3.9 J	NA	NA
Aldrin	0.19 U	2 U	NA	NA
alpha-BHC	0.69 U	2 U	NA	NA
beta-BHC	0.62 U	2 U	NA	NA
Chlordane (technical)	4 U	20 U	NA	NA
delta-BHC	0.31 U	2 U	NA	NA
Dieldrin	0.46 U	3.9 U	NA	NA
Endosulfan I	0.21 U	2 U	NA	NA
Endosulfan II	0.36 U	3.9 U	NA	NA
Endosulfan sulfate	0.49 U	3.9 U	NA	NA
Endrin	0.43 U	3.9 U	NA	NA
Endrin aldehyde	0.86 U	3.9 U	NA	NA
Endrin ketone	0.43 U	3.9 U	NA	NA
gamma-BHC (Lindane)	0.19 U	2 U	NA	NA
Heptachlor	0.43 U	2 U	NA	NA
Heptachlor epoxide	0.28 U	2 U	NA	NA
Isodrin	0.44 U	3.9 U	NA	NA
Kepone	8.9 U	200 U	NA	NA
Methoxychlor	0.62 U	20 U	NA	NA
Toxaphene	16 U	200 U	NA	NA

TABLE 4-8
UPLAND REFERENCE AREA NO. 3 SUBSURFACE SOIL ANALYTICAL RESULTS: VERIFICATION
OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-SB09	REF-SB010	REF-SB011	REF-SB012
Sample ID	REF-SB09	REF-SB010	REF-SB011	REF-SB012
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)				
Antimony	0.5 U	24	0.42 U	0.42 U
Arsenic	1 J	1.1	NA	NA
Barium	150 J	260 J	NA	NA
Beryllium	0.32	0.38	NA	NA
Cadmium	0.061 J	0.071 J	NA	NA
Chromium	56	42	NA	NA
Cobalt	28	50	NA	NA
Copper	98	88	73	76
Lead	2.4	3.4	6	5.4
Mercury	0.037	0.04	0.027	0.024
Nickel	17	17	NA	NA
Selenium	0.47 J	0.86 J	NA	NA
Silver	0.12 U	0.11 U	NA	NA
Thallium	0.12 U	0.11 U	NA	NA
Tin	12 U	11 U	NA	NA
Vanadium	230	250	NA	NA
Zinc	34	42	65	62
General Chemistry				
pH	8.72	7.71	7.85	8.06
TOC (mg/kg)	3,400	19,000	7,700	12,000
Grain Size (percent)				
Gravel	2.2	2	42.6	7
Sand	38.8	31.6	21.4	24.2
Coarse Sand	1.8	2.6	4.2	5.5
Medium Sand	7.4	6.5	7.3	7.8
Fine Sand	29.6	22.5	9.8	11
Silt	16.3	23.9	11	22.9
Clay	42.8	42.6	25	45.9
Soil Textural Classification ⁽³⁾	Clay	Clay	Silt Loam	Clay

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

PAH = Polycyclic Aromatic Hydrocarbon
TOC = Total Organic Carbon
ug/kg = microgram per kilogram
mg/kg = milligram per kilogram

LMW = Low Molecular Weight
HMW = High Molecular Weight
NA = Not Analyzed
bgs = below ground surface

TABLE 4-8
UPLAND REFERENCE AREA NO. 3 SUBSURFACE SOIL ANALYTICAL RESULTS: VERIFICATION
OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

- ⁽¹⁾ Low molecular weight (LMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of fewer than four rings. The LMW PAH compounds analyzed for in SWMU 2 soil were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. For a given sample, the LWM PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected LMW PAHs).
- ⁽²⁾ High molecular weight (HMW) PAHs are defined by the USEPA (2007) as PAH compounds composed of four or more rings. The HMW PAH compounds analyzed for in SWMU 2 soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, pyrene, and indeno(1,2,3-cd)pyrene. For a given sample, the high molecular weight PAH concentration was derived by summing reported concentrations (reporting limit used for non-detected HMW PAHs).
- ⁽³⁾ Soil textural classifications were identified using a computer program (Gerakis and Baer, 1999).

Table References:

Gerakis, A. and B. Baer. 1999. A Computer Program for Soil Textural Classification. Soil. Sci. Soc. Am. J. 63:807-808.

USEPA. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

TABLE 4-9
QUALITY ASSURANCE/QUALITY CONTROL ANALYTICAL RESULTS FOR SOIL AND ESTUARINE WETLAND
SEDIMENT COLLECTION ACTIVITIES: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	1V-ER01 ⁽¹⁾	2V-ER01 ⁽²⁾	REF-ER01 ⁽¹⁾	1V-FB01 ⁽³⁾
Sampling Date	2/27/2007	2/28/2007	3/1/2007	2/27/2007
PAHs (ug/L)				
1-Methylnaphthalene	0.19 U	0.19 U	NA	0.19 U
2-Methylnaphthalene	0.19 U	0.19 U	NA	0.19 U
Acenaphthene	0.19 U	0.19 U	NA	0.19 U
Acenaphthylene	0.19 U	0.19 U	NA	0.19 U
Anthracene	0.19 U	0.19 U	NA	0.19 U
Benzo[a]anthracene	0.19 U	0.19 U	NA	0.19 U
Benzo[a]pyrene	0.19 U	0.19 U	NA	0.19 U
Benzo[b]fluoranthene	0.19 U	0.19 U	NA	0.19 U
Benzo[g,h,i]perylene	0.19 U	0.19 U	NA	0.19 U
Benzo[k]fluoranthene	0.19 U	0.19 U	NA	0.19 U
Chrysene	0.19 U	0.19 U	NA	0.19 U
Dibenz(a,h)anthracene	0.19 U	0.19 U	NA	0.19 U
Fluoranthene	0.19 U	0.19 U	NA	0.19 U
Fluorene	0.19 U	0.19 U	NA	0.19 U
Indeno[1,2,3-cd]pyrene	0.19 U	0.19 U	NA	0.19 U
Naphthalene	0.19 U	0.19 U	NA	0.19 U
Phenanthrene	0.19 U	0.19 U	NA	0.19 U
Pyrene	0.19 U	0.19 U	NA	0.19 U
Pesticides (ug/L)				
4,4'-DDD	0.098 U	0.097 U	NA	0.097 U
4,4'-DDE	0.098 U	0.097 U	NA	0.097 U
4,4'-DDT	0.098 U	0.097 U	NA	0.097 U
Aldrin	0.049 U	0.049 U	NA	0.049 U
alpha-BHC	0.049 U	0.049 U	NA	0.049 U
beta-BHC	0.049 U	0.049 U	NA	0.049 U
Chlordane (technical)	0.49 U	0.49 U	NA	0.49 U
delta-BHC	0.049 U	0.049 U	NA	0.049 U
Dieldrin	0.098 U	0.097 U	NA	0.097 U
Endosulfan I	0.049 U	0.049 U	NA	0.049 U
Endosulfan II	0.098 U	0.097 U	NA	0.097 U
Endosulfan sulfate	0.098 U	0.097 U	NA	0.097 U
Endrin	0.098 U	0.097 U	NA	0.097 U
Endrin aldehyde	0.098 U	0.097 U	NA	0.097 U
Endrin ketone	0.098 U	0.097 U	NA	0.097 U
gamma-BHC (Lindane)	0.049 U	0.049 U	NA	0.049 U
Heptachlor	0.049 U	0.049 U	NA	0.049 U
Heptachlor epoxide	0.049 U	0.049 U	NA	0.049 U
Isodrin	0.049 U	0.049 U	NA	0.049 U
Kepone	0.98 U	0.97 U	NA	0.97 U
Methoxychlor	0.49 U	0.49 U	NA	0.49 U
Toxaphene	4.9 U	4.9 U	NA	4.9 U

TABLE 4-9
QUALITY ASSURANCE/QUALITY CONTROL ANALYTICAL RESULTS FOR SOIL AND ESTUARINE WETLAND
SEDIMENT COLLECTION ACTIVITIES: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	1V-ER01 ⁽¹⁾	2V-ER01 ⁽²⁾	REF-ER01 ⁽¹⁾	1V-FB01 ⁽³⁾
Sampling Date	2/27/2007	2/28/2007	3/1/2007	2/27/2007
Metals (ug/L)				
Antimony	2.5 U	2.5 U	NA	2.5 U
Arsenic	2.5 U	2.5 U	NA	2.5 U
Barium	0.97 J	1 J	NA	0.86 J
Beryllium	0.5 U	0.5 U	NA	0.5 U
Cadmium	0.5 U	0.5 U	NA	0.5 U
Chromium	5 U	5 U	NA	5 U
Cobalt	0.5 U	0.5 U	NA	0.5 U
Copper	0.66 J	0.62 J	0.39 U	2.5 U
Lead	1.5 U	1.5 U	0.5 U	1.5 U
Mercury	0.24 U	0.24 U	0.08 U	0.24 U
Nickel	1 U	0.64 J	NA	1 U
Selenium	2.5 U	2.5 U	NA	2.5 U
Silver	1 U	1 U	NA	1 U
Thallium	1 U	1 U	NA	1 U
Tin	6.6	3.9 J	NA	2.5 J
Vanadium	5 U	5 U	NA	5 U
Zinc	7.6 J	5.6 J	4.7 J	5.9 J

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

PAH = Polycyclic Aromatic Hydrocarbon

NA = Not Analyzed

ug/L = microgram per liter

⁽¹⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused stainless steel spoon.

⁽²⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused stainless steel hand auger.

⁽³⁾ The field blank was collected using laboratory-grade deionized water.

TABLE 4-10
SWMU 2 ESTUARINE WETLAND SEDIMENT ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2V-EWSD01	2V-EWSD02	2V-EWSD03	2V-EWSD04	2V-EWSD05	2V-EWSD06
Sample ID	2V-EWSD01	2V-EWSD02	2V-EWSD03	2V-EWSD04	2V-EWSD05	2V-EWSD06
Sampling Date	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007	2/28/2007
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
General Chemistry						
Ammonia (mg/kg)	3.7	2.0	3.6	16	3.4	5.6
pH	7.85	7.70	7.25	7.56	7.77	7.41
Sulfide (mg/kg)	39 U	41 U	150	250	85	71
Grain Size (percent)						
Gravel	0.7	0.3	2.6	2.6	0.0	6.4
Sand	55.6	36.7	29.7	28.1	9.2	17.1
Coarse Sand	4.1	0.6	1.4	2.6	1.1	4.9
Medium Sand	17.5	3.7	3.9	3.1	0.6	4.4
Fine Sand	33.9	32.4	24.4	22.3	7.5	7.8
Silt	26.5	36.4	38.8	40.2	45.2	23
Clay	17.3	26.7	28.9	29.1	45.6	53.5

Notes:

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

mg/kg = milligram per kilogram

bgs = below ground surface

TABLE 4-11
ESTUARINE WETLAND REFERENCE AREA SEDIMENT ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF-EWSD01	REF-EWSD01D	REF-EWSD02	REF-EWSD03	REF-EWSD04	REF-EWSD05	REF-EWSD06
Sample ID	REF-EWSD01	REF-EWSD01D	REF-EWSD02	REF-EWSD03	REF-EWSD04	REF-EWSD05	REF-EWSD06
Sampling Date	3/1/2007	3/1/2007	3/1/2007	3/1/2007	3/1/2007	3/1/2007	3/1/2007
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)							
Copper	59 J	50 J	58 J	52 J	47 J	36 J	55 J
Lead	2.6	2.4	3.9 J	2.4	3.6 J	3 J	9
Mercury	0.044	0.06	0.07 J	0.058	0.046 J	0.067 J	0.066
Zinc	40 J	30 J	33 J	41 J	28 J	24 J	71 J
General Chemistry							
Ammonia (mg/kg)	8.7	NA	19 J	9.5	19 J	99.6 J	5.5
pH	7.08	NA	7.40	7.05	6.07	6.77	6.97
Sulfide (mg/kg)	47 U	NA	270 J	48 U	470 J	790 J	35 U
TOC (mg/kg)	19,000	NA	96,200	84,000	120,000	120,000	25,000
Grain Size (percent)							
Gravel	3.1	NA	2.5	1.7	0.0	0.0	0.0
Sand	15.6	NA	20.5	13.8	22.1	30.0	0.7
Coarse Sand	1.7	NA	6.8	1.7	2.5	4.6	0.0
Medium Sand	8.0	NA	8.6	7.5	14.6	17.5	0.1
Fine Sand	5.9	NA	5.2	4.6	4.9	8.0	0.6
Silt	22	NA	32.6	60.3	34.6	26.5	26.5
Clay	59.2	NA	44.4	24.3	43.4	43.6	72.8

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

NA = Not Analyzed mg/kg = milligram per kilogram
TOC = Total Organic Carbon bgs = below ground surface

TABLE 4-12
TOTAL ORGANIC CARBON AND GRAIN SIZE ANALYTICAL DATA FOR SWMU 2 ESTUARINE WETLAND SEDIMENT SAMPLES
COLLECTED DURING THE 2003 ADDITIONAL DATA COLLECTION FIELD INVESTIGATIONS
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2EWS01	2EWS02	2EWS03	2EWS04	2EWS05	2EWS06	2EWS07	2EWS07	2EWS08	2EWS09
Sample ID	02EWSSD01	02EWSSD02	02EWSSD03	02EWSSD04	02EWSSD05	02EWSSD06	02EWSSD07	02EWSSD07D	02EWSSD08	02EWSSD09
Sampling Date	7/27/2003	7/27/2003	7/27/2003	7/27/2003	7/27/2003	7/27/2003	7/27/2003	7/27/2003	7/27/2003	7/27/2003
Sample Depth (feet bgs)	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
General Chemistry										
TOC (mg/kg)	73,000	51,000	88,000	44,000	33,000	93,000	50,000	38,000	26,000	27,000
Grain Size (percent)										
Gravel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0	0.0
Sand	8.1	15.4	16.5	49.3	35.7	10.4	11.1	NA	19.5	26.2
Coarse Sand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0	0.0
Medium Sand	5.2	4.1	9.8	10.5	11.8	2.7	1.5	NA	5.3	6.2
Fine Sand	2.9	11.3	6.7	38.8	23.9	7.8	9.5	NA	14.2	20.1
Silt/Clay	91.9	84.6	83.5	50.7	64.3	89.6	88.9	NA	80.5	73.8

Notes:

NA = Not Analyzed

TOC = Total Organic Carbon

mg/kg = milligram per kilogram

bgs = below ground surface

TABLE 4-13
OPEN WATER REFERENCE AREA NO. 1 SEDIMENT ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF1-SD01V	REF1-SD02V	REF1-SD03V	REF1-SD04V	REF1-SD05V	REF1-SD06V
Sample ID	REF1-SD01V	REF1-SD02V	REF1-SD03V	REF1-SD04V	REF1-SD05V	REF1-SD06V
Sampling Date ⁽¹⁾	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)						
Arsenic	9 J	6.3	6.4	8.9	6.9 J	6.4
Cadmium	0.039 J	0.061 J	0.054 J	0.093 J	0.076 J	0.06 J
Copper	25 J	35	35	59	33 J	25
Lead	3.9 J	5.7	4.2	4.2	4 J	3.4
Mercury	0.047 J	0.039	0.023 J	0.015 J	0.031 J	0.019 J
Selenium	0.33 J	0.32 J	0.35 J	0.47 J	0.38 J	0.26 J
Zinc	31 J	38	33	36	31 J	25
General Chemistry (mg/kg)						
TOC	66,000	27,000	64,000	60,000	43,000	64,000
Grain Size (percent)						
Gravel	0.4	0.6	1	0.2	15.8	5.3
Sand	53.2	54.8	59.1	57.5	52.7	57.7
Coarse Sand	3.1	4.4	5.8	2.9	4.6	6.2
Medium Sand	11.8	9.3	9.4	12.6	17.7	21.8
Fine Sand	38.3	41.1	43.9	42	30.4	29.7
Silt	29.6	30.5	26.6	29.9	18.7	24.7
Clay	16.8	14.1	13.3	12.5	12.8	12.3

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

TOC = Total Organic Carbon
mg/kg = milligram per kilogram
bgs = below ground surface

⁽¹⁾ Open water reference area sediment samples and associated QA/QC samples were collected during verification of the field sampling design for a BERA at SWMU 45. Analytical data from this sampling event were used to identify an appropriate open water reference area for the BERA at SWMU 2.

TABLE 4-14
OPEN WATER REFERENCE AREA NO. 2 SEDIMENT ANALYTICAL RESULTS: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF2-SD01V	REF2-SD02V	REF2-SD03V	REF2-SD04V	REF2-SD04V	REF2-SD05V	REF2-SD06V
Sample ID	REF2-SD01V	REF2-SD02V	REF2-SD03V	REF2-SD04V	REF2-SD04VD	REF2-SD05V	REF2-SD06V
Sampling Date ⁽¹⁾	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006	9/20/2006
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)							
Arsenic	2.2 J	2.1 J	2.1	0.84 J	0.95	1.4	2.6 J
Cadmium	0.19 UJ	0.2 UJ	0.17 U	0.18 U	0.17 U	0.18 U	0.22 UJ
Copper	4.4 J	7.4 J	3.3	1.2	1.6	2.2	5.1 J
Lead	1.3 J	2 J	1.3	0.45 J	0.6	1.1	1.4 J
Mercury	0.036 UJ	0.011 J	0.032 U	0.033 U	0.037 U	0.037 U	0.041 UJ
Selenium	0.28 J	0.3 J	0.22 J	0.89 U	0.87 U	0.88 U	0.29 J
Zinc	7.7 UJ	9.4 J	6.8 U	7.1 U	7 U	7 U	8.8 UJ
General Chemistry (mg/kg)							
TOC	20,000	17,000	17,000	9,300	NA	12,000	67,000
Grain Size (percent)							
Gravel	3.7	8.7	2.8	0.9	NA	3.7	0.3
Sand	73.5	60.4	77.8	70.9	NA	69.9	69.7
Coarse Sand	2.9	3.8	10.0	4.9	NA	5.2	3.2
Medium Sand	9.6	20.0	18.9	24.0	NA	16.8	15.5
Fine Sand	61.0	36.6	48.8	41.9	NA	47.9	51
Silt	11.5	20.3	8.1	19.4	NA	18.4	16.1
Clay	11.3	10.6	11.2	8.9	NA	8.0	13.9

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

UJ = The analyte was analyzed for, but not detected; The reported sample quantitation limit is qualified as estimated

TOC = Total Organic Carbon

bgs = below ground surface

mg/kg = milligram per kilogram

⁽¹⁾ Open water reference area sediment samples were collected during verification of the field sampling design for a BERA at SWMU 45. Analytical data from this sampling event were used to identify an appropriate open water reference area for the BERA at SWMU 1.

TABLE 4-15
OPEN WATER REFERENCE AREA NO. 3 SEDIMENT ANALYTICAL RESULTS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF3-SD01V	REF3-SD01V	REF3-SD02V
Sample ID	REF3-SD01V	REF3-SD01VD	REF3-SD02V
Sampling Date	9/21/2006	9/21/2006	9/21/2006
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)			
Arsenic	4.3	5	3.1
Cadmium	0.15 U	0.15 U	0.16 U
Copper	16	31	12
Lead	0.87 R	3.8	2.3
Mercury	0.028 U	0.012 J	0.03 U
Selenium	0.73 U	0.32 J	0.78 U
Zinc	14 J	23 J	11
General Chemistry (mg/kg)			
TOC	5,100	NA	24,000
Grain Size (percent)			
Gravel	34.7	NA	32.5
Sand	59.7	NA	46.8
Coarse Sand	5.8	NA	7.3
Medium Sand	18.9	NA	12.1
Fine Sand	34.9	NA	27.4
Silt	2.4	NA	10.5
Clay	3.3	NA	10.2

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

TOC = Total Organic Carbon

mg/kg = milligram per kilogram

bgs = below ground surface

⁽¹⁾ Open water reference area sediment samples were collected during verification of the field sampling design for a BERA at SWMU 45. Analytical data from this sampling event were used to identify an appropriate open water reference area for the BERA at SWMU 1.

TABLE 4-16
QUALITY ASSURANCE/QUALITY CONTROL ANALYTICAL RESULTS FOR OPEN WATER SEDIMENT
COLLECTION ACTIVITIES: VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	45B-ER01V ⁽¹⁾	45B-FB01V ⁽²⁾
Sampling Date	9/20/2006	9/20/2006
Metals (ug/L)		
Arsenic	2.5 U	2.5 U
Cadmium	0.5 U	0.5 U
Copper	2.5 U	0.52 J
Lead	1.5 U	1.5 U
Mercury	0.2 U	0.2 U
Selenium	2.5 U	2.5 U
Zinc	20 U	20 U

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

ug/L = microgram per liter

⁽¹⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused sediment core liner.

⁽²⁾ The field blank was collected using laboratory-grade deionized water.

TABLE 4-17
TOTAL ORGANIC CARBON AND GRAIN SIZE ANALYTICAL DATA FOR SWMU 2 OPEN WATER SEDIMENT SAMPLES
COLLECTED DURING THE 2003 ADDITIONAL DATA COLLECTION FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2OW01	2OW02	2OW03	2OW04	2OW05	2OW06	2OW07	2OW08	2OW09
Sample ID	02OWSD01	02OWSD02	02OWSD03	02OWSD04	02OWSD05	02OWSD06	02OWSD07	02OWSD08	02OWSD09
Sample Date	07/27/03	07/27/03	07/28/03	07/28/03	07/28/03	07/27/03	07/27/03	07/28/03	07/28/03
Sample Depth (feet bgs)	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5	0.0 - 0.5
General Chemistry (mg/kg)									
Total Organic Carbon	30,000	48,000	55,000	20,000	28,000	31,000	22,000	18,000	25,000
Grain Size (percent)									
Gravel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sand	27.3	37.9	31.6	48.6	18.5	43.8	52.7	20.3	12.9
Coarse Sand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Medium Sand	1.4	1.6	4.4	11.8	5.2	1.9	6.6	3.9	3.1
Fine Sand	25.9	36.4	27.2	36.8	13.3	41.9	46.0	16.4	9.8
Silt/Clay	72.7	62.1	68.4	51.4	81.5	56.2	47.3	79.7	87.1

Notes:

bgs = below ground surface

mg/kg = milligram per kilogram

TABLE 4-18
SWMU 2 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK
ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-SB01	2B-SB02	2B-SB03	2B-SB04	2B-SB04	2B-BS05	2B-SB06	2B-SB07
Sample ID	2B-SS01	2B-SS02	2B-SS03	2B-SS04	2B-SS04D	2B-SS05	2B-SS06	2B-SS07
Sampling Date	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)								
Antimony	1.1 J	1 J	2.1 J	1.8 J	5.2 J	1.5 J	0.057 J	0.057 J
Copper	391 J	140 J	499 J	219 J	274 J	409 J	266 J	130 J
Lead	602	85.4	388	3,550 J	1,580 J	746	94.6	161
Mercury	0.28 J	0.2 J	0.075 J	0.48 J	0.36 J	0.099 J	0.31 J	0.15 J
Zinc	1,220 J	252 J	483 J	345 J	644 J	441 J	68.5 J	85 J

TABLE 4-18
SWMU 2 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK
ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-SB08	2B-SB09	2B-SB10	2B-SS11	2B-SS12	2B-SS13	2B-SS14	2B-SS14
Sample ID	2B-SS08	2B-SS09	2B-SS10	2B-SS11	2B-SS12	2B-SS13	2B-SS14	2B-SS14D
Sampling Date	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)								
Antimony	0.072 J	0.066 J	0.28 J	0.28 J	0.077 J	0.38 J	0.76 J	0.99 J
Copper	71 J	152 J	135 J	64.7 J	55.9 J	137 J	74.1 J	73.4 J
Lead	31.6	156	113	418	99.2	305	795	667
Mercury	0.097 J	0.28 J	0.35 J	0.77 J	0.36 J	8.7 J	4.2 J	4.1 J
Zinc	51.5 J	114 J	124 J	1,110 J	154 J	196 J	179 J	154 J

TABLE 4-18
SWMU 2 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK
ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-SS15	2B-SS16	2B-SS17	2B-SS18	2B-SS19	2B-SS20	2B-SS21	2B-SS22
Sample ID	2B-SS15	2B-SS16	2B-SS17	2B-SS18	2B-SS19	2B-SS20	2B-SS21	2B-SS22
Sampling Date	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)								
Antimony	0.051 J	0.036 J	0.06 J	0.07 J	0.12 J	0.23 J	0.052 J	0.11 J
Copper	67.9 J	94.2 J	75.2 J	84.2 J	109 J	354 J	45.4 J	69.7 J
Lead	84.8	37.8	79.2	74.7	139	387	27.9	85.6
Mercury	0.23 J	0.06 J	0.21 J	0.52 J	0.23 J	0.043	0.073	0.13 J
Zinc	169 J	64.1 J	106 J	72 J	162 J	546 J	50 J	118 J

TABLE 4-18
SWMU 2 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK
ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-SS23	2B-SS24	2B-SS24	2B-SS25	2B-SS26	2B-SS27	2B-SS28	2B-SS29
Sample ID	2B-SS23	2B-SS24	2B-SS24D	2B-SS25	2B-SS26	2B-SS27	2B-SS28	2B-SS29
Sampling Date	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)								
Antimony	0.25 J	1.1	1	0.097 J	0.34 J	0.056 J	0.044 J	0.13 J
Copper	85.2 J	130	99	102 J	85.7 J	66.6 J	83 J	90.9 J
Lead	158	140	130	79.6	180	45.5	54.7	58.6
Mercury	0.18	0.16	0.18	0.15	0.14	0.055	0.038	0.073
Zinc	166 J	260	210	167 J	249 J	83.2 J	119 J	143 J

TABLE 4-18
SWMU 2 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK
ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-SS30	2B-SS31	2B-SS32	2B-SS33	2B-SS34	2B-SS34	2B-SS35	2B-SS36
Sample ID	2B-SS30	2B-SS31	2B-SS32	2B-SS33	2B-SS34	2B-SS34D	2B-SS35	2B-SS36
Sampling Date	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)								
Antimony	0.042 J	2.3 J	2.4 J	1 J	0.73 J	1 J	0.34 J	0.57 J
Copper	72.2 J	19,300 J	353 J	357 J	8,130 J	8,530 J	242 J	92.8 J
Lead	26.6	314	366	279 J	637 J	1,040	118	210
Mercury	0.073	0.17	0.11	0.13	0.2	0.25	0.2	0.21
Zinc	99.7 J	5,080 J	1,350 J	12,700 J	2,710 J	1,380 J	345 J	292 J

TABLE 4-18
SWMU 2 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK
ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-SS37	2B-SS38	2B-SS39	2B-SS40	2B-SS41	2B-SS42	2B-SS43	2B-SS44
Sample ID	2B-SS37	2B-SS38	2B-SS39	2B-SS40	2B-SS41	2B-SS42	2B-SS43	2B-SS44
Sampling Date	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)								
Antimony	0.8 J	0.33 J	3.2	2.1	6.6	1.5	0.83	8.7
Copper	150 J	67.3 J	61	120	170	300	240	200
Lead	293	104	110	120	260	130	53	290
Mercury	0.24	0.11	0.29	0.31	0.31	0.51	0.068	0.43
Zinc	153 J	207 J	180	220	760	210	160	1,100

TABLE 4-18
SWMU 2 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK
ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-SS44	2B-SS45	2B-SS46	2B-SS47	2B-SS48	2B-SS49	2B-SS50
Sample ID	2B-SS44D	2B-SS45	2B-SS46	2B-SS47	2B-SS48	2B-SS49	2B-SS50
Sampling Date	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)							
Antimony	8.2	1.6	0.19 U	0.22 U	0.15 U	0.24 U	0.22 U
Copper	190	260	45	53	36	41	75
Lead	310	110	24	7.8	10	8.1	17
Mercury	0.46	0.87	0.056	0.077	0.12	0.048	0.026
Zinc	930	190	36	37	26	32	50

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

bgs = below ground surface

mg/kg = milligram per kilogram

TABLE 4-19
SWMU 2 QUICK-TURN SUBSURFACE SOIL ANALYTICAL RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-SB01	2B-SB02	2B-SB04	2B-SB04	2B-SB06	2B-SB07	2B-SB08	2B-SB09	2B-SB10
Sample ID	2B-SB01-01	2B-SB02-01	2B-SB04-01	2B-SB04-01D	2B-SB06-01	2B-SB07-01	2B-SB08-01	2B-SB09-01	2B-SB10-01
Sampling Date	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007	5/18/2007
Depth range (feet bgs)	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0
Metals (mg/kg)									
Antimony	2.2	7.1	36	33	1.9	0.42	1.4	2.8	0.62
Copper	120	140	270 J	1,000 J	140	110	150	340	110
Lead	100	77	1,300	1,400	130	240	34	140	50
Mercury	0.035 J	0.12 J	0.68 J	0.94 J	0.44 J	0.24 J	0.09 J	0.57 J	0.17 J
Zinc	470	340	590	3,800	130	130	110	120	180

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit

bgs = below ground surface

mg/kg = milligram per kilogram

TABLE 4-20
UPLAND REFERENCE AREA NO. 2 QUICK-TURN SURFACE SOIL ANALYTICAL RESULTS: BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-REF-SB01	2B-REF-SB02	2B-REF-SB03	2B-REF-SB04	2B-REF-SB04	2B-REF-SB05	2B-REF-SB06
Sample ID	2B-REF-SS01	2B-REF-SS02	2B-REF-SS03	2B-REF-SS04	2B-REF-SS04D	2B-REF-SS05	2B-REF-SS06
Sampling Date	5/20/2007	5/20/2007	5/20/2007	5/20/2007	5/20/2007	5/20/2007	5/20/2007
Depth Range (feet bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)							
Antimony	0.17 U	0.14 U	0.26 UJ	0.74	0.29 U	0.18 U	0.23 U
Copper	94	74	97	100 J	100 J	83 J	92 J
Lead	4.6	2.2	5	29 J	4.6 J	3 J	6 J
Mercury	0.029	0.022	0.036	0.038	0.044	0.034	0.03
Zinc	42	32	49	49 J	47 J	37 J	49 J

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

UJ = The analyte was analyzed for, but not detected at the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

bgs = below ground surface

mg/kg = milligram per kilogram

TABLE 4-21
UPLAND REFERENCE AREA NO. 2 QUICK-TURN SUBSURFACE SOIL ANALYTICAL RESULTS: BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-REF-SB01	2B-REF-SB02	2B-REF-SB03	2B-REF-SB04	2B-REF-SB04	2B-REF-SB05	2B-REF-SB06
Sample ID	2B-REF-SB01-01	2B-REF-SB02-01	2B-REF-SB03-01	2B-REF-SB04-01	2B-REF-SB04-01D	2B-REF-SB05-01	2B-REF-SB06-01
Sampling Date	5/20/2007	5/20/2007	5/20/2007	5/20/2007	5/20/2007	5/20/2007	5/20/2007
Depth Range (feet bgs)	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0
Metals (mg/kg)							
Antimony	0.17 U	0.19 U	0.2 U	0.21 U	0.21 U	0.23 U	0.25 U
Copper	74	62	58	63	84	95	69
Lead	2.1	4.1	4.9	2.5	3	7.5	5.5
Mercury	0.024 U	0.039	0.059	0.021 U	0.023	0.02 U	0.041
Zinc	30	35	39	31	36	37	49

Notes:

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

bgs = below ground surface

mg/kg = milligram per kilogram

TABLE 4-22
QUALITY ASSURANCE/QUALITY CONTROL ANALYTICAL RESULTS FOR SOIL AND SEDIMENT COLLECTION
ACTIVITIES: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	2B-ER01 ⁽¹⁾	2B-ER02 ⁽²⁾	2B-ER03 ⁽³⁾	2B-FBO1 ⁽⁴⁾	2B-FB02 ⁽⁵⁾
Sampling Date	5/21/2007	5/21/2007	5/21/2007	5/21/2007	5/21/2007
Metals (mg/kg)					
Antimony	1 J	1 U	1 U	1 U	1 U
Arsenic	0.6 U	NA	NA	0.6 U	0.6 U
Cadmium	0.1 U	NA	NA	0.1 U	0.1 U
Copper	0.72 J	0.6 J	0.47 J	0.52 J	16
Lead	0.5 U	0.5 U	0.5 U	0.5 U	1.4 J
Mercury	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U
Selenium	0.5 U	NA	NA	0.5 U	0.5 U
Zinc	3.5 U	4.9 J	3.5 U	3.5 U	11 J

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Quantitation Limit or Contract Required Detection Limit

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

mg/kg = milligram per kilogram

⁽¹⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused stainless steel spoon.

⁽²⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water through an unused bucket auger.

⁽³⁾ The equipment rinsate blank was collected by passing laboratory-grade deionized water over an unused aluminum pan.

⁽⁴⁾ The field blank was collected using potable water.

⁽⁵⁾ The field blank was collected using laboratory-grade deionized water.

TABLE 4-23
MAXIMUM, 95 PERCENT UPPER CONFIDENCE LIMIT OF THE MEAN, AND ARITHMETIC MEAN HAZARD QUOTIENT VALUES FOR SOIL INVERTEBRATE
EXPOSURES TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 2 SURFACE AND SUBSURFACE SOIL
SWMU 2 – LANGLEY DRIVE DISPOSAL AREA
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Analyte	Contaminant Frequency/Range ⁽¹⁾						Soil Screening Values (SSV) ⁽⁴⁾	Max. HQ ⁽⁵⁾	95 Percent UCL HQ ⁽⁶⁾	Arithmetic Mean HQ ⁽⁷⁾
	No. of Positive Detects/No. of Samples	Range of Positive Detections	Range of Non-Detects	Maximum Detected Concentration	95 Percent UCL of the Mean Concentration ⁽²⁾	Arithmetic Mean Concentration ⁽³⁾				
Metals (mg/kg)										
Antimony	80/94	0.036J - 36	0.15UJ - 4UJ	36	6.17	2.58	78	0.46	0.08	0.03
Copper	93/94	16.9 - 19,300J	4.3B	19,300	1,546	547.93	80	241.25	19.33	6.85
Lead	94/94	3.1 - 5,850J	NA	5,850	503.4	354.52	1,700	3.44	0.30	0.21
Mercury	88/94	0.026 - 19J	0.12U - 0.16U	19	1.513	0.54	0.1	190.00	15.13	5.41
Zinc	94/94	8.3 - 12,700J	NA	12,700	1,566	602.22	120	105.83	13.05	5.02

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

B = Reported values is less than the Contract Required Detection Limit, but greater than the instrument detection limit; Value is treated as not detected

UJ = The analyte was analyzed for, but not detected at the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

SSV = Soil Screening Value

UCL = Upper Confidence Limit

HQ = Hazard Quotient

µg/kg = microgram per kilogram

mg/kg = milligram per kilogram

⁽¹⁾ The analytical data used in the evaluation represents a combined soil data set for surface and subsurface soil collected during the 1992 Supplemental Investigation, 2004 additional data collection investigation, and baseline ecological risk assessment field investigation, as well as surface soil collected during the 1996 RFI. The analytical data from the 1992 Supplemental Investigation and 1996 RFI are presented in Tables 2-3 (surface soil) and 2-4 (subsurface soil), while the analytical data from the baseline ecological risk assessment field investigation are presented in Tables 4-18 (surface soil) and 4-19 (subsurface soil). In some cases, duplicate samples were collected in the field. When duplicate samples were collected, maximum detected concentrations (or, in the case of non-detected chemicals, maximum reporting limits) in the original or duplicate sample were used as conservative estimates for contaminant concentrations at that sampling point (results from duplicate samples were not evaluated individually).

⁽²⁾ 95% UCL of the mean concentrations were calculated using USEPA ProUCL Version 4.00.04 software (USEPA, 2009a and 2009b).

⁽³⁾ One-half the reporting limit was used for non-detected results when calculating arithmetic mean concentrations.

⁽⁴⁾ See Table 3-3 for a description, source, and reference citation for each of the screening values listed below.

⁽⁵⁾ For a given chemical, the maximum HQ value was derived by dividing the maximum detected concentration by the soil screening value.

⁽⁶⁾ For a given chemical, the 95 percent UCL of the mean HQ value was derived by dividing the 95 percent UCL of the mean concentration by the soil screening value.

⁽⁷⁾ For a given chemical, the arithmetic mean HQ value was derived by dividing the arithmetic mean concentration by the soil screening value.

Table References

United States Environmental Protection Agency (USEPA). 2009a. ProUCL Version 4.00.04. February 2009. <http://www.epa.gov/esd/tsc/software.htm>.

USEPA. 2009b. ProUCL Version 4.00.04 User Guide (Draft). EPA/600/R-07/038. February 2009. <http://www.epa.gov/esd/tsc/images/ProcUCL%204.00.04/ProUCL%20Version%204.00.04%20User%20Guide.pdf>.

TABLE 4-24
EISENIA FETIDA TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Negative Control	2B-REF-SB01-01	2B-REF-SS04	2B-REF-SS05	2B-SS04	2B-SB04-01 ⁽¹⁾	2B-SS05	2B-SS10
Metals (mg/kg):								
Antimony	NA	0.17 U	0.74	0.18 U	1.8 J	36	1.5 J	0.28 J
Copper	NA	74	100 J	83 J	219 J	1,000 J	409 J	135 J
Lead	NA	2.1	29.0 J	3.0 J	3550 J	1,400	746	113
Mercury	NA	0.024 U	0.038	0.034	0.48 J	0.94 J	0.099 J	0.35 J
Zinc	NA	30	49 J	37 J	345 J	3,800	441 J	124 J
General Chemistry:								
pH ⁽²⁾	7.2/7.8	7.6/9.1	8.7/8.9	8.5/8.6	8.4/8.3	8.3/8.2	8.4/8.4	8.0/7.9
TOC (mg/kg)	NA	9,900	10,000	19,000	31,000	26,000	27,000	34,000
Grain Size (percent)								
Gravel	NA	15.2	3.4	16.3	29.5	38.6	29.8	23.0
Sand	NA	46.8	15.0	45.4	41.8	19.6	40.0	31.3
Fines (silt and clay)	NA	38.0	81.6	38.3	28.7	41.8	30.2	45.7
Toxicity Test Results:								
Survival (percent):								
Replicate A	100	100	100	100	100	0	100	100
Replicate B	100	100	100	100	100	0	100	100
Replicate C	100	100	100	100	100	0	100	100
Replicate D	100	100	100	100	100	0	100	100
Replicate E	90	100	100	100	90	0	90	100
Replicate F	100	100	100	100	90	0	90	90
Replicate G	100	100	100	100	100	0	100	100
Replicate H	100	100	100	100	100	0	100	100
Median	100.00	100.00	100.00	100.00	100.00	<u>0.00</u>	100.00	100.00
Growth (wet weight loss per surviving worm in grams):								
Replicate A	0.0231	0.1339	0.2106	0.1272	0.0755	--	0.0994	0.0709
Replicate B	0.0273	0.0876	0.2072	0.1146	0.1091	--	0.0563	0.0310
Replicate C	0.043	0.1263	0.1576	0.0924	0.0699	--	0.1037	0.0557
Replicate D	0.0602	0.0916	0.1598	0.0986	0.0510	--	0.0929	0.0668
Replicate E	0.1467	0.1355	0.1329	0.1340	0.1023	--	0.0877	0.0446
Replicate F	0.0639	0.1551	0.1787	0.0900	0.1127	--	0.0893	0.0884
Replicate G	0.0596	0.1214	0.1600	0.0627	0.1266	--	0.1203	0.0863
Replicate H	0.0251	0.1387	0.1471	0.0748	0.1343	--	0.0878	0.0747
Mean	0.0561	0.1238	0.1692	0.0993	<u>0.0977</u>	--	<u>0.0922</u>	<u>0.0648</u>
Reproduction (juevenes/cocoons per surviving worms):								
Replicate A	0.600	0.000	0.000	0.000	0.000	--	0.000	0.000
Replicate B	0.900	0.000	0.000	0.000	0.000	--	0.000	0.000
Replicate C	0.700	0.000	0.000	0.000	0.000	--	0.000	0.000
Replicate D	0.700	0.000	0.000	0.000	0.000	--	0.000	0.000
Replicate E	0.667	0.000	0.000	0.000	0.000	--	0.000	0.000
Replicate F	0.800	0.000	0.000	0.000	0.000	--	0.000	0.000
Replicate G	0.800	0.000	0.000	0.000	0.000	--	0.000	0.000
Replicate H	0.700	0.000	0.000	0.000	0.000	--	0.000	0.000
Median	0.700	0.000	0.000	0.000	0.000	--	0.000	0.000

TABLE 4-24
EISENIA FETIDA TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	2B-SS13	2B-SS14	2B-SS31	2B-SS33	2B-SS34	2B-SS41	2B-SS44	2B-SS49
Metals (mg/kg):								
Antimony	0.38 J	0.76 J	2.3 J	1 J	0.73 J	6.6	8.7	0.24 U
Copper	137 J	74.1 J	19,300 J	357 J	8,130 J	170	200	41
Lead	305	795	314	279 J	637 J	260	290	8.1
Mercury	8.7 J	4.2 J	0.17	0.13	0.2	0.31	0.43	0.048
Zinc	196 J	179 J	5,080 J	12,700 J	2,710 J	760	1,100	32
General Chemistry:								
pH ⁽²⁾	8.5/9.1	8.1/8.5	7.7/8.1	7.8/8.2	7.8/8.5	7.0/8.5	7.2/8.6	7.2/8.9
TOC (mg/kg)	33,000	61,000	45,000	29,000	17,000	35,000	30,000	32,000
Grain Size (percent)								
Gravel	30.2	21.1	32.3	31.7	14.7	15.1	13.9	4.8
Sand	30.2	48.1	45.8	49.3	39.7	39.8	40.5	13.6
Fines (silt and clay)	39.6	30.8	21.9	19.0	45.7	45.0	45.6	81.6
Toxicity Test Results:								
Survival (percent):								
Replicate A	90	100	100	100	0	100	100	100
Replicate B	100	100	90	100	0	100	100	100
Replicate C	100	100	100	100	0	100	100	80
Replicate D	100	100	90	100	0	100	100	100
Replicate E	100	100	100	100	10	90	100	100
Replicate F	100	100	100	90	0	100	100	100
Replicate G	100	100	100	100	0	100	100	90
Replicate H	100	100	100	100	0	90	100	100
Median	100.00	100.00	100	100.00	<u>0.00</u>	100.00	100.00	100.00
Growth (wet weight loss per surviving worm in grams):								
Replicate A	0.1228	0.0085	0.1576	0.0542	--	0.1415	0.0923	0.1404
Replicate B	0.0726	0.1054	0.1994	0.0669	--	0.1285	0.0883	0.1427
Replicate C	0.1179	0.0735	0.1654	0.0642	--	0.1077	0.0781	0.2100
Replicate D	0.1327	0.0772	0.1902	0.0107	--	0.1184	0.0903	0.1451
Replicate E	0.1300	0.0199	0.1655	0.0591	0.3446	0.1762	0.0766	0.1248
Replicate F	0.0890	0.0651	0.1576	0.0407	--	0.1254	0.0650	0.1613
Replicate G	0.1290	0.0980	0.2314	0.1007	--	0.1120	0.1592	0.1789
Replicate H	0.1165	0.0317	0.1516	0.0998	--	0.1264	0.1222	0.1579
Mean	<u>0.1138</u>	<u>0.0599</u>	<u>0.1773</u>	<u>0.0620</u>	0.3446 ⁽³⁾	<u>0.1295</u>	<u>0.0965</u>	<u>0.1576</u>
Reproduction (juevenes/cocoons per surviving worms):								
Replicate A	0.000	0.200	1.000	0.000	--	0.600	0.200	0.100
Replicate B	0.200	0.000	0.889	0.000	--	0.600	0.700	0.100
Replicate C	0.000	0.000	0.700	0.000	--	0.400	0.500	0.000
Replicate D	0.000	0.000	0.778	0.000	--	0.500	0.400	0.000
Replicate E	0.000	0.200	0.900	0.000	0.000	0.667	0.500	0.000
Replicate F	0.000	0.000	0.800	0.000	--	0.300	0.300	0.200
Replicate G	0.100	0.000	0.400	0.000	--	0.400	0.400	0.000
Replicate H	0.100	0.000	0.600	0.000	--	0.778	0.600	0.000
Median	0.050	0.000	<u>0.789</u>	0.000	0.000	<u>0.550</u>	<u>0.450</u>	0.000

TABLE 4-24
EISENIA FETIDA TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA
SWMU 1 - ARMY CREMATOR DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes:

Bold indicates endpoint is significantly different than 2B-REF-SB01-01 ($\alpha = 0.05$) as determined by a multiple comparison method (i.e., Dunn's Method or Bonferroni t-test)
Underline indicates endpoint is significantly different than 2B-REF-SS04 ($\alpha = 0.05$) as determined by a multiple comparison method (i.e., Dunn's Method or Bonferroni t-test)
Italics indicates endpoint is significantly different than 2B-REF-SS05 ($\alpha = 0.05$) as determined by a multiple comparison method (i.e., Dunn's Method or Bonferroni t-test)
Shading indicates an adverse effect (i.e., significantly lower survival, significantly greater weight loss, or significantly lower reproduction than earthworms exposed to reference soils)

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

mg/kg = milligram per kilogram
NA = Not Analyzed

- ⁽¹⁾ The sample was duplicated in the field. The maximum reported antimony, copper, lead, mercury and zinc concentration in the original and duplicate sample is shown.
- ⁽²⁾ The values shown (pH at test initiation/pH at test termination) were measured by the toxicity testing laboratory (Fort Environmental Laboratories, Inc.). All other general chemistry measurements were performed by the analytical laboratory (Severn Trent laboratories, Inc.).
- ⁽³⁾ Soil sample 2B-SS34 was excluded from the statistical evaluation of growth and reprocuton data because the sample size was too small to be conducive to hypothesis testing (only one test organism survived until test termination).

TABLE 4-25
CORRELATION COEFFICIENT AND COEFFICIENT OF DETERMINATION VALUES: EARTHWORM SURVIVAL AND
WEIGHT LOSS PER SURVIVING EARTHWORM VERSUS SOIL VARIABLES
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Variable ⁽¹⁾	Earthworm Survival			Weight Loss Per Surviving Earthworm		
	Correlation Coefficient Value (unitless)	Coefficient of Determination Value (unitless)	Significant at Alpha = 0.05 (Yes/No)	Correlation Coefficient Value (unitless)	Coefficient of Determination Value (unitless)	Significant at Alpha = 0.05 (Yes/No)
Ecological COCs:						
Antimony	-0.6544	0.4283	Yes	-0.0828	0.0069	No
Copper	-0.2230	0.0497	No	0.5202	0.2706	No
Lead	-0.2402	0.0577	No	-0.0813	0.0066	No
Mercury	0.0931	0.0087	No	-0.1787	0.0319	No
Zinc	-0.1963	0.0385	No	-0.0228	0.0005	No
Physical/Chemical Properties:						
TOC	0.1982	0.0393	No	-0.3693	0.1364	No
pH (test initiation) ⁽¹⁾	-0.0797	0.0064	No	-0.0374	0.0014	No
pH (test termination) ⁽²⁾	0.1768	0.0312	No	0.269	0.0724	No
Percent gravel	-0.2699	0.0729	No	-0.3465	0.1201	No
Percent sand	0.2658	0.0706	No	-0.216	0.0467	No
Percent fines	-0.0194	0.0004	No	0.3106	0.0965	No

Notes:

TOC = Total Organic Carbon

COC = Chemical of Concern

⁽¹⁾ The pH was measured by the toxicity testing laboratory at test initiation.

⁽²⁾ The pH was measured by the toxicity testing laboratory at test termination.

TABLE 4-26
SWMU 2 EARTHWORM TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS):
BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID ⁽¹⁾	2B-SB04-01 ⁽²⁾	2B-SS04	2B-SS05	2B-SS10	2B-SS13	2B-SS14
Sampling Date	7/3/2007	7/3/2007	7/3/2007	7/3/2007	7/3/2007	7/3/2007
<u>Wet Weight Basis:</u>						
Metals (mg/kg)						
Antimony	NA	0.065 U	0.12 J	0.071 U	0.074 U	0.11 J
Copper	NA	4	5.6	5	3.7	3.4
Lead	NA	0.98	1.7	1.7	1.4	7.6
Mercury	NA	0.05	0.078	0.062	0.21	0.18
Zinc	NA	18	18	17	18	20
<u>Dry Weight Basis ⁽⁴⁾:</u>						
Metals (mg/kg)						
Antimony	NA	0.41 U	0.75 J	0.44 U	0.46 U	0.69 J
Copper	NA	25	35	31	23	21
Lead	NA	6.1	11	11	8.8	47.5
Mercury	NA	0.31	0.49	0.39	1.3	1.1
Zinc	NA	113	113	106	113	125
Lipids (percent)	NA	0.26	0.16	0.13	0.20	0.06

TABLE 4-26
SWMU 2 EARTHWORM TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS):
BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID ⁽¹⁾	2B-SS31	2B-SS33	2B-SS34 ⁽³⁾	2B-SS41	2B-SS44	2B-SS49
Sampling Date	7/3/2007	7/3/2007	7/3/2007	7/3/2007	7/3/2007	7/3/2007
<u>Wet Weight Basis:</u>						
Metals (mg/kg)						
Antimony	0.086 J	0.13 J	1.3 U	0.072 J	0.19 J	0.073 U
Copper	5.5	10	14 J	3.4	4.6	2.2
Lead	1.2	4	4.6 J	1.3	3.3	0.58
Mercury	0.012 J	0.071	0.75 U	0.047	0.077	0.015 J
Zinc	17	81	16 J	21	24	17
<u>Dry Weight Basis ⁽⁴⁾:</u>						
Metals (mg/kg)						
Antimony	0.54 J	0.81 J	8.1 U	0.45 J	1.2 J	0.46 U
Copper	34	63	88 J	21	29	14
Lead	7.5	25	29 J	8.1	21	3.6
Mercury	0.075 J	0.44	4.7 U	0.29	0.48	0.094 J
Zinc	106	506	100 J	131	150	106
Lipids (percent)	0.11	0.06	NA	0.05	0.15	0.17

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

mg/kg = milligram per kilogram

NA = Not Available

⁽¹⁾ Earthworm tissue sample identification numbers correspond to the surface soil samples earthworms were exposed to during the toxicity tests.

⁽²⁾ All earthworms exposed to this soil sample died prior to the termination of the toxicity test. Therefore, tissue was not available for analytical testing.

TABLE 4-26
SWMU 2 EARTHWORM TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS):
BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

- ⁽³⁾ The mass of earthworm tissue available at test termination was insufficient for the analysis of percent lipids.
- ⁽⁴⁾ For a given earthworm tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by 0.16 (estimated solids content of earthworms [USEPA, 1993]).

Table References:

United States Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

TABLE 4-27
UPLAND REFERENCE AREA NO. 2 EARTHWORM TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID ⁽¹⁾	2B-REF-SB01-01	2B-REF-SS04	2B-REF-SS05
Date	7/3/2007	7/3/2007	7/3/2007
<u>Wet Weight Basis:</u>			
Metals (mg/kg)			
Antimony	0.075 U	0.064 U	0.071 U
Copper	2.9	1.9	4
Lead	0.76	0.075 U	0.16 J
Mercury	0.0082 J	0.013 J	0.02
Zinc	16	14	17
<u>Dry Weight Basis ⁽²⁾:</u>			
Metals (mg/kg)			
Antimony	0.47 U	0.40 U	0.44 U
Copper	18	12	25
Lead	4.8	0.47 U	1.0 J
Mercury	0.051 J	0.081 J	0.13
Zinc	100	88	106
Lipids (percent)	0.13	0.24	0.22

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

mg/kg = milligram per kilogram

⁽¹⁾ Earthworm tissue sample identification numbers correspond to the surface soil samples earthworms were exposed to during the toxicity tests.

⁽²⁾ For a given earthworm tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by 0.16 (estimated solids content of earthworms [USEPA, 1993]).

Table References:

United States Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

TABLE 4-28
SUMMARY OF 95 PERCENT UPPER CONFIDENCE LIMIT OF THE MEAN HAZARD QUOTIENT VALUES FOR
AMERICAN ROBIN DIETARY EXPOSURES TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 2 SOIL
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values ⁽¹⁾		
	NOAEL	MATC	LOAEL
Metals:			
Antimony	<0.01	<0.01	<0.01
Copper	2.74	1.58	0.92
Lead	2.10	1.48	1.05
Mercury	2.10	1.21	0.70
Zinc	0.26	0.16	0.10

Shaded cells indicate a Hazard Quotient (HQ) greater than 1.0.

Notes:

NOAEL = No Observed Adverse Effect Level

LOAEL = Lowest Observed Adverse Effect Level

MATC = Maximum Acceptable Toxicant Concentration

⁽¹⁾ Risk estimates (i.e., HQ values) were estimated using 95 percent UCL of the mean soil and earthworm tissue concentrations.

TABLE 4-29
MARY OF MAXIMUM HAZARD QUOTIENT VALUES FOR AMERICAN ROBIN DIETARY EXPOSURE
TO COPPER, LEAD, AND MERCURY IN UPLAND REFERENCE AREA NO. 2 SOIL
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values: SWMU 2 ⁽¹⁾		
	NOAEL	MATC	LOAEL
Metals:			
Copper	0.39	0.23	0.13
Lead	0.21	0.15	0.11
Mercury	0.23	0.13	0.08

Shaded cells indicate a Hazard Quotient (HQ) greater than 1.0.

Notes:

NOAEL = No Observed Adverse Effect Level

LOAEL = Lowest Observed Adverse Effect Level

MATC = Maximum Acceptable Toxicant Concentration

⁽¹⁾ Risk estimates (i.e., HQ values) were estimated using maximum soil and earthworm tissue concentrations.

TABLE 4-30
SWMU 2 QUICK-TURN ESTUARINE WETLAND SEDIMENT ANALYTICAL RESULTS: BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-EWSD01	2B-EWSD02	2B-EWSD03	2B-EWSD04	2B-EWSD04	2B-EWSD05	2B-EWSD06	2B-EWSD07	2B-EWSD08
Sample ID	2B-EWSD01	2B-EWSD02	2B-EWSD03	2B-EWSD04	2B-EWSD04D	2B-EWSD05	2B-EWSD06	2B-EWSD07	2B-EWSD08
Sampling Date	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007
Depth range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)									
Copper	16 J	28 J	10 J	21 J	19 J	38 J	45 J	20 J	12 J
Lead	3.6 J	5.2 J	1.2 J	3.4 J	3.6 J	4.7 J	4.6 J	7.3 J	4.7
Mercury	0.026 J	0.026 J	0.031	0.03 J	0.026 J	0.049 J	0.061 J	0.034	0.024 J
Zinc	15 J	27 J	10 J	18 J	17 J	31 J	33 J	19 J	14

TABLE 4-30
SWMU 2 QUICK-TURN ESTUARINE WETLAND SEDIMENT ANALYTICAL RESULTS: BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-EWSD09	2B-EWSD10	2B-EWSD11	2B-EWSD12	2B-EWSD13	2B-EWSD14	2B-EWSD14	2B-EWSD15
Sample ID	2B-EWSD09	2B-EWSD10	2B-EWSD11	2B-EWSD12	2B-EWSD13	2B-EWSD14	2B-EWSD14D	2B-EWSD15
Sampling Date	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007
Depth range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)								
Copper	340 J	83 J	60 J	67 J	83 J	84 J	95 J	220 J
Lead	440	21 J	7.4 J	13 J	20 J	23 J	26 J	120
Mercury	0.46	0.26 J	0.065 J	0.083 J	0.13 J	0.099 J	0.095 J	0.47
Zinc	420	65 J	42 J	44 J	57 J	62 J	65 J	240

TABLE 4-30
SWMU 2 QUICK-TURN ESTUARINE WETLAND SEDIMENT ANALYTICAL RESULTS: BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-EWSD16	2B-EWSD18	2B-EWSD19	2B-EWSD20	2B-EWSD21	2B-EWSD22	2B-EWSD23	2B-EWSD24
Sample ID	2B-EWSD16	2B-EWSD18	2B-EWSD19	2B-EWSD20	2B-EWSD21	2B-EWSD22	2B-EWSD23	2B-EWSD24
Sampling Date	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007
Depth range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)								
Copper	170 J	710 J	140 J	130 J	90 J	100 J	140 J	200 J
Lead	200	450 J	32 J	37 J	28 J	24 J	9.3	90
Mercury	0.81	0.27 J	0.09 J	0.18 J	0.097 J	0.099 J	0.13	0.1
Zinc	270	200 J	89 J	88 J	62 J	65 J	79	210

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit

bgs = below ground surface

mg/kg = milligram per kilogram

TABLE 4-31
ESTUARINE WETLAND REFERENCE AREA QUICK-TURN SEDIMENT ANALYTICAL RESULTS: BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-REF-EWSD01	2B-REF-EWSD02	2B-REF-EWSD03	2B-REF-EWSD04	2B-REF-EWSD04D	2B-REF-EWSD05	2B-REF-EWSD06
Sample ID	2B-REF-EWSD01	2B-REF-EWSD02	2B-REF-EWSD03	2B-REF-EWSD04	2B-REF-EWSD04D	2B-REF-EWSD05	2B-REF-EWSD06
Sampling Date	5/20/2007	5/20/2007	5/20/2007	5/20/2007	5/20/2007	5/20/2007	5/20/2007
Depth Range (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)							
Copper	60 J	56 J	140 J	51 J	46 J	75 J	64 J
Lead	1.2 J	4.3 J	5.3 J	8.3 J	5 J	3.5 J	8.4 J
Mercury (mg/kg)	0.063 J	0.066 J	0.055	0.035	0.046	0.034	0.037
Zinc	18 J	40 J	40 J	70 J	54 J	57 J	68 J

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit

bgs = below ground surface

mg/kg = milligram per kilogram

TABLE 4-32
MAXIMUM, 95 PERCENT UPPER CONFIDENCE LIMIT OF THE MEAN, AND ARITHMETIC MEAN HAZARD QUOTIENT VALUES FOR BENTHIC INVERTEBRATE
EXPOSURES TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 2 ESTUARINE WETLAND SEDIMENT
SWMU 2 – LANGLEY DRIVE DISPOSAL AREA
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Analyte	Contaminant Frequency/Range ⁽¹⁾						Sediment Screening Values (SDSV) ⁽⁴⁾	Max. HQ ⁽⁵⁾	95 Percent UCL HQ ⁽⁶⁾	Arithmetic Mean HQ ⁽⁷⁾
	No. of Positive Detects/No. of Samples	Range of Positive Detections	Range of Non-Detects	Maximum Detected Concentration	95 Percent UCL of the Mean Concentration ⁽²⁾	Arithmetic Mean Concentration ⁽³⁾				
Metals (mg/kg)										
Copper	42/42	10J - 710J	NA	710	140.1	108.19	18.7	37.97	7.49	5.79
Lead	40/40	1.2J - 450J	NA	450	96.83	51.285	30.2	14.90	3.21	1.70
Mercury ⁽⁸⁾	40/40	0.015J - 1.3	NA	1.3	0.262	0.172	0.13	10.00	2.02	1.32
Zinc	32/32	10J - 420	NA	420	110.6	81.28	124	3.39	0.89	0.66

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

SDSV = Sediment Screening Value

HQ = Hazard Quotient

UCL = Upper Confidence Limit

mg/kg = milligram per kilogram

⁽¹⁾ The analytical data used in the evaluation represent a combined data set for estuarine wetland sediment collected during the 2003 and 2004 additional data collection field investigations, as well as estuarine wetland sediment collected during the baseline ecological risk assessment field investigation. Analytical data from the 2003 and 2004 additional data collection field investigations are presented in Table 2-9, while analytical data from the baseline ecological risk assessment field investigation are presented in Table 4-30. In some cases, duplicate samples were collected in the field. When duplicate samples were collected, maximum detected concentrations (or, in the case of non-detected chemicals, maximum reporting limits) in the original or duplicate sample were used as conservative estimates for contaminant concentrations at that sampling point.

⁽²⁾ 95% UCL of the mean concentrations were calculated using USEPA ProUCL Version 4.00.04 software (USEPA, 2009a and 2009b).

⁽³⁾ One-half the reporting limit was used for non-detected results when calculating arithmetic mean concentrations.

⁽⁴⁾ The sediment screening values listed below are Threshold Effect Concentrations developed by MacDonald (1994). These values were used as ecological effect concentrations in the screening-level ecological risk assessment and Step 3a of the baseline ecological risk assessment (Baker, 2006).

⁽⁵⁾ For a given chemical, the maximum HQ value was derived by dividing the maximum detected concentration by the soil screening value.

⁽⁶⁾ For a given chemical, the 95 percent UCL of the mean HQ value was derived by dividing the 95 percent UCL of the mean concentration by the soil screening value.

⁽⁷⁾ For a given chemical, the arithmetic mean HQ value was derived by dividing the arithmetic mean concentration by the soil screening value.

⁽⁸⁾ Mercury was not identified as an ecological COC for estuarine wetland benthic invertebrate communities in Step 3a of the baseline ecological risk. This metal was included in the assessment of the SWMU 2 quick-turn estuarine wetland analytical data based on the frequency of detected concentrations above the sediment screening value (fourteen of forty [14/40] sediment samples).

Table References

Baker Environmental, Inc. (Baker). 2006. Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2, Naval Activity Puerto Rico, Ceiba, Puerto Rico. Coraopolis, Pennsylvania. May 18, 2006.

MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Florida Department of Environmental Protection. Office of Water Quality. 199 pp.

United States Environmental Protection Agency (USEPA). 2009a. ProUCL Version 4.00.04. February 2009. <http://www.epa.gov/esd/tsc/software.htm>.

USEPA. 2009b. ProUCL Version 4.00.04 User Guide (Draft). EPA/600/R-07/038. February 2009. <http://www.epa.gov/esd/tsc/images/ProcUCL%204.00.04/ProUCL%20Version%204.00.04%20User%20Guide.pdf>.

TABLE 4-33
ACID VOLATILE SULFIDE/SIMULTANEOUSLY EXTRACTED METALS ANALYTICAL DATA FROM THE
2004 ADDITIONAL DATA COLLECTION FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2EWSD10	2EWSD11	2EWSD12	2EWSD13	2EWSD14	2EWSD15	2EWSD16	2EWSD17	2EWSD18	2EWSD19
Sample ID	2EWSD10	2EWSD11	2EWSD12	2EWSD13	2EWSD14	2EWSD15	2EWSD16	2EWSD17	2EWSD18	2EWSD19
Sampling Date	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04	10/04/04
Sample Depth (feet bgs)	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33	0.00 - 0.33
AVS (μmole/g)										
Acid Volatile Sulfide	0.4055	6.8621	0.1248 U	16.5315	28.0724	18.0911	19.9626	74.8596	0.9981	34.3107
SEM (μmole/g) ⁽¹⁾										
Cadmium	0.0005 J	0.0013 J	0.0012	0.0013 J	0.0033	0.0006 J	0.0017 J	0.0012 J	0.0007 J	0.0011 J
Copper	0.0077 J	0.0127 J	2.0458 J	0.0173 J	0.2518 J	0.0519 J	0.1574 J	0.0834 J	0.1495 J	0.1054 J
Nickel	0.0111 J	0.0204 J	0.0699	0.0160 J	0.0273	0.0145 J	0.0307 J	0.0204 J	0.0221 J	0.0290
Lead	0.0077 J	0.0140 J	0.6757 J	0.0193 J	0.1593 J	0.0179 J	0.1014 J	0.0579 J	0.0179 J	0.0579 J
Zinc	0.0382 J	0.2141	3.5174	0.1682	1.1928	0.1178	0.5353	0.3670	0.1330	0.3517
Total SEM (μmole/g) ⁽²⁾	0.0652	0.2626	6.3099	0.2222	1.6344	0.2026	0.8263	0.5300	0.3233	0.5451

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit

AVS = Acid Volatile Sulfide

SEM = Simultaneously Extracted Metals

μmole/g = micromole per gram

bgs = below ground surface

⁽¹⁾ SWMU 2 estuarine wetland sediment samples collected during the 2004 additional data collection field investigation were not analyzed for the SEM metal silver.

⁽²⁾ The total SEM concentration was derived using the following formula: $[SEM]_{total} = [SEM]_{Cd} + [SEM]_{Cu} + [SEM]_{Pb} + [SEM]_{Ni} + [SEM]_{Zn}$

TABLE 4-34
ACID VOLATILE SULFIDE/SIMULTANEOUSLY EXTRACTED METALS ANALYTICAL DATA: BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-EWSD04	2B-EWSD09	2B-EWSD12	2B-EWSD15	2B-EWSD16	2B-EWSD18	2B-EWSD20	2B-EWSD24
Sample ID	680-26880-17	680-26880-23	680-26880-26	680-26880-30	680-26880-31	680-26880-32	680-26880-34	680-26880-38
Sampling Date	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007	5/19/2007
Sample Depth (feet bgs)	Solid	Solid	Solid	Solid	Solid	Solid	Solid	Solid
AVS (μmole/g)								
Acid Volatile Sulfide	1.1541	0.0561 U	2.7137 J	1.2477 J	0.0468 U	11.5409 J	5.3026 J	0.0530 U
SEM (μmole/g)								
Cadmium	0.0019 J	0.0048	0.0021 J	0.0030 J	0.0024	0.0063 J	0.0040 J	0.0017
Copper	0.1385 J	3.7768	0.0897 J	2.2031 J	1.5737	0.7239 J	0.4878 J	1.3219
Lead	0.0179 J	2.3166 J	0.0347 J	0.6274 J	0.4247 J	1.1100 J	0.1158 J	0.2654 J
Nickel	0.0239 J	0.0494	0.0221 J	0.0375 J	0.0170	0.0426 J	0.0341 J	0.0162
Silver	0.0003 UJ	0.0003 J	0.0005 UJ	0.0003 UJ	0.0001 U	0.0003 UJ	0.0061 J	0.0005 J
Zinc	0.1453 J	2.9056 J	0.3670 J	2.7527 J	0.5505 J	1.4681 J	0.5505 J	0.8105 J
Total SEM (μmole/g) ⁽¹⁾⁽²⁾	0.3275	9.0536	0.5160	5.6239	2.5684	3.3511	1.1984	2.4162

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract

Required Quantitation Limit or Contract Required Detection Limit

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

UJ = The analyte was analyzed for, but not detected at the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

AVS = Acid Volatile Sulfide

SEM = Simultaneously Extracted Metals

μmole/g = micromole per gram

bgs = below ground surface

⁽¹⁾ The total SEM concentration was derived using the following formula: $[SEM]_{total} = [SEM]^{Cd} + [SEM]_{Cu} + [SEM]_{Pb} + [SEM]_{Ni} + [SEM]_{Zn} + (0.5)[SEM]_{Ag}$
(one-half the molar concentration of silver was added into the SEM totals due to silver being largely in a monovalent state)

⁽²⁾ If a given sediment sample had non-detected results for individual SEM metals, the non-detected results were used in the derivation of the total SEM molar concentration.

TABLE 4-35
SIMULTANEOUSLY EXTRACTED METALS-TO-ACID VOLATILE SULFIDE RATIOS FOR SEDIMENT COLLECTED DURING THE
2004 ADDITIONAL DATA COLLECTION AND BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATIONS
ASSESSMENT FIELD INVESTIGATIONS
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT AND STEP 3A OF THE BASELINE
ECOLOGICAL RISK ASSESSMENT
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Investigation	Sample Identification	Total SEM Concentration (μmole/g)	Acid Volatile Sulfide Concentration (μmole/g)	SEM/AVS Ratio (unitless)	Potential for Toxicity ⁽¹⁾ (Yes/No)
2004 Additional Data Collection Investigation ⁽²⁾	2EWSD10	0.0652	0.4055	0.16	No
	2EWSD11	0.0383	6.8621	0.01	No
	2EWSD12	6.3099	0.1248	126.20	Yes
	2EWSD13	0.2222	16.5315	0.01	No
	2EWSD14	1.6344	28.0724	0.06	No
	2EWSD15	0.2026	18.0911	0.01	No
	2EWSD16	0.8263	19.9626	0.04	No
	2EWSD17	0.5300	74.8596	0.01	No
	2EWSD18	0.3233	0.9981	0.32	No
	2EWSD19	0.5451	34.3107	0.02	No
BERA Field Investigation	2B-EWSD04	0.3275	1.1541	0.28	No
	2B-EWSD09	9.0536	0.0561	161.38	Yes
	2B-EWSD12	0.5160	2.7137	0.19	No
	2B-EWSD15	5.6239	1.2477	4.51	Yes
	2B-EWSD16	2.5684	0.0468	54.88	Yes
	2B-EWSD18	3.3511	11.5409	0.29	No
	2B-EWSD20	1.1984	5.3026	0.23	No
	2B-EWSD24	2.4162	0.0530	45.59	Yes

Notes:

Shading indicates that the SEM-to-AVS ratio is greater than 1.0

umole/g = micromole per gram

AVS = Acid Volatile Sulfide

SEM = Simultaneously Extracted Metals

⁽¹⁾ Toxicity is predicted when the ratio SEM/AVS is greater than 1.0.

⁽²⁾ Sediment samples collected during the 2004 additional data collection field investigation were not analyzed for silver. Therefore, the total SEM molar concentrations shown for these samples do not reflect contributions from this metal.

TABLE 4-36
LEPTOCHEIRUS PLUMULOSUS TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Negative Control	2B-REF-EWSD01	2B-REF-EWSD02	2B-EWSD04 ⁽¹⁾	2B-EWSD09	2B-EWSD12	2B-EWSD15	2B-EWSD16	2B-EWSD18	2B-EWSD20	2B-EWSD24
Metals (mg/kg) ⁽¹⁾:											
Copper	NA	60 J	56 J	21 J	340 J	67 J	220 J	170 J	710 J	130 J	200 J
Lead	NA	1.2 J	4.3 J	3.6 J	440	13 J	120	200	450 J	37 J	90
Mercury	NA	0.063 J	0.066 J	0.03 J	0.46	0.083 J	0.47	0.81	0.27 J	0.18 J	0.1
Zinc	NA	18 J	40 J	18 J	420	44 J	240	270	200 J	88 J	210
Acid Volatile Sulfide (AVS) and Simultaneously Extrated Metals (SEM) ⁽²⁾:											
SEM (µmole/gram)											
Cadmium	NA	0.0010 J	0.0077 UJ	0.0019 J	0.0048	0.0021 J	0.0030 J	0.0024	0.0063 J	0.0040 J	0.0017
Copper	NA	0.1306 J	0.1180 J	0.1385 J	3.7768	0.0897 J	2.2031 J	1.5737	0.7239 J	0.4878 J	1.3219
Lead	NA	0.0036 J	0.0097 J	0.0179 J	2.3166 J	0.0347 J	0.6274 J	0.4247 J	1.1100 J	0.1158 J	0.2654 J
Nickel	NA	0.0039 J	0.0170 UJ	0.0239 J	0.0494	0.0221 J	0.0375 J	0.0170	0.0426 J	0.0341 J	0.0162
Silver	NA	0.0004 J	0.0034 UJ	0.0002 UJ	0.0003 J	0.0005 UJ	0.0003 UJ	0.0001 U	0.0003 UJ	0.0061 J	0.0005 J
Zinc	NA	0.0612 J	0.0948 J	0.1453 J	2.9056 J	0.3670 J	2.7527 J	0.5505 J	1.4681 J	0.5505 J	0.8105 J
AVS (µmole/gram)	NA	0.1216 UJ	0.1092 UJ	1.1541	0.0561 U	2.7137 J	1.2477 J	0.0468 U	11.5409 J	5.3026 J	0.0530 U
SEM-to-AVS ratio (unitless)	---	1.6488	2.2793	0.2837	161.3828	0.1901	4.5074	54.8810	0.2904	0.2260	45.5889
Physical/Chemical Properties ⁽²⁾:											
Total ammonia (mg/kg)	NA	11	13	5.4	2.3	110	5.3	1.7	8.6	12	1.4
Sulfide (mg/kg)	NA	76 U	67 U	53 U	34 U	180	56 U	30 U	190	120 U	32 U
pH	NA	5.17	4.59	7.59	8.61	7.26	7.21	7.99	7.51	7.34	8.34
Total Organic Carbon (mg/kg)	NA	110,000	52,000	50,000	28,000	99,000	69,000	26,000	59,000	120,000	21,000
Grain Size (percent)											
Gravel	NA	0.0	0.0	0.0	4.6	0.0	4.9	2.5	0.0	0.0	7.2
Sand	NA	20.8	11.5	16.2	39.2	16.7	25.4	18.5	8.8	22.3	36.2
Fines (silt and clay)	NA	79.2	88.5	83.8	56.3	83.3	69.7	79.0	91.2	77.7	56.6
Overlying Water Chemistry ⁽³⁾⁽⁴⁾:											
Salinity (ppt)											
Day 0	28.3	32.4	31.7	30.7	30.9	30.9	31.1	30.4	30.3	30.9	30.2
Day 28	29.8	31.5	31.7	31.5	31.1	31.1	31.7	31.1	31.3	31.4	31.3
Total ammonia (mg/L)											
Day 0	0.30	1.15	2.90	0.40	0.40	0.95	0.50	0.55	0.55	0.70	0.70
Day 28	0.55	4.15	6.88	0.25	0.10	0.80	6.95	0.15	0.60	0.20	0.30
Sulfide (mg/L)											
Day 0	<0.01	0.01	0.01	<0.01	<0.01	0.03	0.02	<0.01	<0.01	<0.01	<0.01
Day 28	<0.01	0.07	0.03	<0.01	0.01	0.02	<0.01	0.01	<0.01	0.01	<0.01
pH											
Day 0	7.3	7.6	7.6	7.6	7.8	7.8	7.9	7.9	8.0	8.0	8.0
Day 28	7.7	8.0	6.5	7.9	8.0	8.0	8.0	8.1	7.9	8.0	8.0
Pore Water Chemistry ⁽³⁾:											
Salinity (ppt)											
Day 0	NA	57.5	52.5	43.1	NA ⁽⁵⁾	36.9	54.2	NA ⁽⁵⁾	NA ⁽⁵⁾	39.9	NA ⁽⁵⁾
Day 28	42.4	45.8	49.7	47.0	45.5	47.1	55.4	48.1	48.0	43.9	42.1
Total ammonia (mg/L)											
Day 0	NA	0.75	2.08	0.65	NA ⁽⁵⁾	0.50	0.80	NA ⁽⁵⁾	NA ⁽⁵⁾	0.75	NA ⁽⁵⁾
Day 28	0.15	5.05	8.40	0.40	1.20	0.60	2.90	1.10	1.40	0.45	0.40
Sulfide (mg/L)											
Day 0	NA	0.10	0.06	0.08	NA ⁽⁵⁾	0.11	1.11	NA ⁽⁵⁾	NA ⁽⁵⁾	0.12	NA ⁽⁵⁾
Day 28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

TABLE 4-36
LEPTOCHEIRUS PLUMULOSUS TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Negative Control	2B-REF-EWSD01	2B-REF-EWSD02	2B-EWSD04 ⁽¹⁾	2B-EWSD09	2B-EWSD12	2B-EWSD15	2B-EWSD16	2B-EWSD18	2B-EWSD20	2B-EWSD24
Pore Water Chemistry (continued) ⁽³⁾ :											
pH											
Day 0	NA	7.7	7.0	7.5	NA ⁽⁵⁾	7.7	7.8	NA ⁽⁵⁾	NA ⁽⁵⁾	7.9	NA ⁽⁵⁾
Day 28	7.4	7.9	6.5	7.4	7.4	7.5	7.6	7.8	7.8	7.8	7.8
Toxicity Test Results:											
Survival (percent):											
Replicate A	95	90	95	0	0	0	0	15	0	10	0
Replicate B	100	85	75	35	0	0	0	10	0	20	0
Replicate C	100	100	100	20	5	5	0	5	0	15	0
Replicate D	90	100	100	15	0	5	10	5	0	0	0
Replicate E	90	95	100	30	0	10	0	20	0	5	0
Replicate F	100	85	85	10	0	0	5	10	0	0	0
Replicate G	100	100	95	30	0	0	5	0	0	0	0
Replicate H	100	95	100	20	0	5	0	10	0	10	0
Median	100.00	95.00	97.50	20.00	0.00	2.50	0.00	10.00	0.00	7.50	0.00
Growth (dry weight per surviving amphipod per replicate in milligrams):											
Replicate A	0.1053	0.0944	0.1316	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁶⁾	0.0667	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁶⁾
Replicate B	0.0950	0.0882	0.1000	0.0714	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁶⁾	0.0500	--- ⁽⁶⁾
Replicate C	0.1100	0.1150	0.1300	0.0500	--- ⁽⁷⁾	--- ⁽⁷⁾	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁶⁾	0.0333	--- ⁽⁶⁾
Replicate D	0.0889	0.1200	0.1450	0.0333	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁷⁾	--- ⁽⁷⁾	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁶⁾
Replicate E	0.1333	0.1053	0.1350	0.0667	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁶⁾	0.0750	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁶⁾
Replicate F	0.0959	0.0941	0.1118	--- ⁽⁷⁾	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁷⁾	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁶⁾
Replicate G	0.1150	0.1100	0.1211	0.0500	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁶⁾	--- ⁽⁶⁾
Replicate H	0.1050	0.1105	0.1500	0.0500	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁶⁾	--- ⁽⁷⁾	--- ⁽⁶⁾
Mean	0.1059	0.1047	0.1280	0.0536	---	---	---	0.0708	---	0.0417	---
Reproduction (reproduction per surviving amphipod per replicate):											
Replicate A	0.632	0.556	0.895	--- ⁽⁸⁾	--- ⁽⁸⁾	--- ⁽⁸⁾	--- ⁽⁸⁾	1.667	--- ⁽⁸⁾	0.000	--- ⁽⁸⁾
Replicate B	0.650	0.765	1.067	0.429	--- ⁽⁸⁾	--- ⁽⁸⁾	--- ⁽⁸⁾	1.500	--- ⁽⁸⁾	0.750	--- ⁽⁸⁾
Replicate C	0.750	0.750	1.000	0.500	0.000	0.000	--- ⁽⁸⁾	0.000	--- ⁽⁸⁾	1.333	--- ⁽⁸⁾
Replicate D	0.556	0.850	0.900	1.333	--- ⁽⁸⁾	0.000	0.000	0.000	--- ⁽⁸⁾	--- ⁽⁸⁾	--- ⁽⁸⁾
Replicate E	0.444	0.632	0.950	0.000	--- ⁽⁸⁾	0.000	--- ⁽⁸⁾	1.000	--- ⁽⁸⁾	0.000	--- ⁽⁸⁾
Replicate F	0.650	0.588	0.647	0.000	--- ⁽⁸⁾	--- ⁽⁸⁾	0.000	0.000	--- ⁽⁸⁾	--- ⁽⁸⁾	--- ⁽⁸⁾
Replicate G	0.550	0.400	0.737	0.333	--- ⁽⁸⁾	--- ⁽⁸⁾	0.000	--- ⁽⁸⁾	--- ⁽⁸⁾	--- ⁽⁸⁾	--- ⁽⁸⁾
Replicate H	0.500	0.684	1.100	0.500	--- ⁽⁸⁾	0.000	--- ⁽⁸⁾	1.500	--- ⁽⁸⁾	0.000	--- ⁽⁸⁾
Median	0.594	0.658	0.925	0.429	0.000	0.000	0.000	1.000	---	0.417	---

Notes:

Underline indicates endpoint is significantly different than 2B-REF-EWSD01 ($\alpha = 0.05$) as determined by a multiple comparison method (i.e., Dunn's Method or Bonferroni t-test)
Italics indicates endpoint is significantly different than 2B-REF-EWSD02 ($\alpha = 0.05$) as determined by a multiple comparison method (i.e., Dunn's Method or Bonferroni t-test)
Shading indicates an adverse effect (i.e., significantly lower survival, significantly greater weight loss, or significantly lower reproduction than amphipods exposed to reference sediments)

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
UJ = The analyte was analyzed for, but not detected at the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

TABLE 4-36
LEPTOCHEIRUS PLUMULOSUS TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

NA = Not analyzed
mg/L = milligram per liter
mg/kg = milligram per kilogram
< = less than
AVS = Acid Volatile Sulfide
SEM = Simultaneously Extracted Metals
ppt = parts per thousand

- ⁽¹⁾ The sample was duplicated in the field. Maximum reported copper, lead, mercury, and zinc concentrations in the original sample or duplicate sample are shown.
- ⁽²⁾ Analyses were performed by the analytical laboratory (Severn Trent laboratories, Inc.).
- ⁽³⁾ Analyses were performed by the toxicity testing laboratory (Fort Environmental Laboratories, Inc.).
- ⁽⁴⁾ For a given sediment treatment, pH and and salinity analyses were performed on overlying water from one randomly selected replicate at test initiation (day 0) and on days 4, 6, 8, 11, 13, 15, 18, 20, 22, 25, and 28 of the toxicity tests. Total Ammonia and sulfide analyses also were performed on overlying water from one randomly selected replicate at test initiation (day 0) and on days 4, 6, 8, 13, 20, and 28 of the toxicity tests. Results of the pH, salinity, total ammonia, and sulfide measurements conducted on overlying water on days 4, 6, 8, 11, 13, 15, 18, 20, 22, and 25 of the toxicity tests are presented within the testing laboratory's toxicity report (see Appendix B).
- ⁽⁵⁾ The sample lacked sufficient pore water to conduct the analysis.
- ⁽⁶⁾ There were no surviving amphipods at test termination. Therefore, a growth measurement for this replicate (i.e., dry weight per surviving amphipod) could not be performed.
- ⁽⁷⁾ The biomass recovered from this replicate at test termination was insufficient for a growth measurement (i.e., dry weight per surviving amphipod).
- ⁽⁸⁾ There were no surviving amphipods at test termination. Therefore, a reproduction measurement for this replicate (i.e., number of juveniles and cocoons per surviving amphipod) could not be performed.

TABLE 4-37
CORRELATION COEFFICIENT AND COEFFICIENT OF DETERMINATION VALUES: AMPHIPOD SURVIVAL AND
DRY WEIGHT PER SURVIVING AMPHIPOD VERSUS SEDIMENT, OVERLYING WATER, AND PORE WATER VARIABLES
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Variable	Amphipod Survival			Dry Weight Per Surviving Amphipod		
	Correlation Coefficient Value (unitless)	Coefficient of Determination Value (unitless)	Significant at Alpha = 0.05 (Yes/No)	Correlation Coefficient Value (unitless)	Coefficient of Determination Value (unitless)	Significant at Alpha = 0.05 (Yes/No)
Ecological COCs:						
Copper	-0.5285	0.2790	No	-0.3231	0.1044	No
Lead	-0.5348	0.2860	No	-0.2486	0.0618	No
Mercury	-0.3753	0.1409	No	-0.2143	0.0459	No
Zinc	-0.5999	0.3599	No	-0.2527	0.0639	No
Physical/Chemical Properties:						
SEM-to-AVS ratio	-0.3264	0.1065	No	-0.1032	0.0106	No
Ammonia	-0.0775	0.0060	No	0.4126	0.1703	No
Sulfide	-0.1668	0.0278	No	-0.2289	0.0524	No
pH	-0.9223	0.8506	Yes	-0.8981	0.8066	Yes
TOC	0.3036	0.0922	No	-0.1451	0.0211	No
Percent gravel	-0.4885	0.2386	No	-0.1394	0.0194	No
Percent sand	-0.3710	0.1376	No	-0.5984	0.3581	No
Percent fines	0.4088	0.1672	No	0.6018	0.3622	No
Overlying Water Chemistry ⁽¹⁾⁽²⁾:						
Salinity	0.7123	0.5074	Yes	0.8494	0.7215	No
Total ammonia	0.8067	0.6508	Yes	0.9335	0.8714	Yes
pH	-0.7832	0.6134	Yes	-0.9187	0.8440	Yes
Pore Water Chemistry ⁽¹⁾⁽³⁾⁽⁴⁾:						
Salinity (day 28)	-0.1307	0.0171	No	0.2418	0.0585	No
Total ammonia (day 28)	0.5746	0.3302	No	0.7498	0.5621	No
pH (day 28)	-0.4518	0.2041	No	-0.5847	0.3419	No

Notes:

TOC = Total Organic Carbon COC = Chemical of Concern

⁽¹⁾ Overlying and pore water measurements were conducted by the toxicity testing laboratory.

⁽²⁾ No regression was performed on sulfide concentrations in overlying water due to low intra- and inter-replicate variability throughout the toxicity tests.

⁽³⁾ No regression was performed on pore water parameters at test initiation since four SWMU 2 estuarine wetland sediment samples lacked sufficient pore water to conduct the analyses.

⁽⁴⁾ No regression was performed on pore water sulfide concentrations on day 28 since the sulfide concentration in each treatment was identical (<0.01 mg/L).

TABLE 4-38
NEANTHES ARENACEODENTATA TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Negative Control	2B-REF-EWSD01	2B-REF-EWSD02	2B-EWSD04 ⁽¹⁾	2B-EWSD09	2B-EWSD12	2B-EWSD15	2B-EWSD16	2B-EWSD18	2B-EWSD20	2B-EWSD24
Metals (mg/kg) ⁽¹⁾:											
Copper	NA	60 J	56 J	21 J	340 J	67 J	220 J	170 J	710 J	130 J	200 J
Lead	NA	1.2 J	4.3 J	3.4 J	440	13 J	120	200	450 J	37 J	90
Mercury	NA	0.063 J	0.066 J	0.03 J	0.46	0.083 J	0.47	0.81	0.27 J	0.18 J	0.1
Zinc	NA	18 J	40 J	18 J	420	44 J	240	270	200 J	88 J	210
Acid Volatile Sulfide (AVS) and Simultaneously Extrated Metals (SEM) ⁽²⁾:											
SEM (µmole/gram)											
Cadmium	NA	0.0010 J	0.0077 UJ	0.0019 J	0.0048	0.0021 J	0.0030 J	0.0024	0.0063 J	0.0040 J	0.0017
Copper	NA	0.1306 J	0.1180 J	0.1385 J	3.7768	0.0897 J	2.2031 J	1.5737	0.7239 J	0.4878 J	1.3219
Lead	NA	0.0036 J	0.0097 J	0.0179 J	2.3166 J	0.0347 J	0.6274 J	0.4247 J	1.1100 J	0.1158 J	0.2654 J
Nickel	NA	0.0039 J	0.0170 UJ	0.0239 J	0.0494	0.0221 J	0.0375 J	0.0170	0.0426 J	0.0341 J	0.0162
Silver	NA	0.0004 J	0.0034 UJ	0.0002 UJ	0.0003 J	0.0005 UJ	0.0003 UJ	0.0001 U	0.0003 UJ	0.0061 J	0.0005 J
Zinc	NA	0.0612 J	0.0948 J	0.1453 J	2.9056 J	0.3670 J	2.7527 J	0.5505 J	1.4681 J	0.5505 J	0.8105 J
AVS (µmole/gram)	NA	0.1216 UJ	0.1092 UJ	1.1541	0.0561 U	2.7137 J	1.2477 J	0.0468 U	11.5409 J	5.3026 J	0.0530 U
SEM-to-AVS Ratio (unitless)	---	1.6488	2.2793	0.2837	161.3828	0.1901	4.5074	54.8810	0.2904	0.2260	45.5889
Physical/Chemical Properties ⁽²⁾:											
Total ammonia (mg/kg)	NA	11	13	5.4	2.3	110	5.3	1.7	8.6	12	1.4
Sulfide (mg/kg)	NA	76 U	67 U	53 U	34 U	180	56 U	30 U	190	120 U	32 U
pH	NA	5.17	4.59	7.59	8.61	7.26	7.21	7.99	7.51	7.34	8.34
Total Organic Carbon (mg/kg)	NA	110,000	52,000	50,000	28,000	99,000	69,000	26,000	59,000	120,000	21,000
Grain Size (percent)											
Gravel	NA	0.0	0.0	0.0	4.6	0.0	4.9	2.5	0.0	0.0	7.2
Sand	NA	20.8	11.5	16.2	39.2	16.7	25.4	18.5	8.8	22.3	36.2
Fines (silt and clay)	NA	79.2	88.5	83.8	56.3	83.3	69.7	79.0	91.2	77.7	56.6
Overlying Water Chemistry ⁽³⁾⁽⁴⁾:											
Salinity (ppt)											
Day 0	29.6	31.5	31.6	31.1	31.2	31.4	31.7	30.9	31.1	30.7	31.0
Day 20	38.9	45.8	45.8	43.4	46.4	43.7	47.9	45.0	49.3	44.5	43.1
Total ammonia (mg/L)											
Day 0	0.55	1.05	2.03	0.40	0.30	0.20	1.00	0.05	0.65	0.20	0.15
Day 20	13.10	3.00	3.73	0.50	1.25	0.60	4.85	1.20	1.70	0.50	0.35
Sulfide (mg/L)											
Day 0	0.04	0.04	0.04	<0.01	<0.01	0.01	0.02	0.01	0.01	0.01	0.01
Day 20	0.04	0.01	<0.01	0.01	<0.01	0.01	0.02	<0.01	<0.01	0.01	<0.01
pH											
Day 0	7.3	7.6	7.6	7.6	7.8	7.8	7.9	7.9	8.0	8.0	8.0
Day 20	8.0	7.0	6.5	8.2	8.2	8.2	8.2	8.3	8.1	8.2	8.3
Pore Water Chemistry ⁽³⁾:											
Salinity (ppt)											
Upon Receipt	NA	57.5	52.5	43.1	NA ⁽⁵⁾	36.9	54.2	NA ⁽⁵⁾	NA ⁽⁵⁾	39.9	NA ⁽⁵⁾
Day 20	NA	32.8	59.2	31.7	33.3	49.5	48.9	30.4	31.9	31.1	31.3
Total ammonia (mg/L)											
Upon Receipt	NA	0.75	2.08	0.65	NA ⁽⁵⁾	0.50	0.80	NA ⁽⁵⁾	NA ⁽⁵⁾	0.75	NA ⁽⁵⁾
Day 20	NA	11.35	6.50	5.90	9.45	1.65	2.25	6.20	10.60	8.90	9.40
Sulfide (mg/L)											
Upon Receipt	NA	0.10	0.06	0.08	NA ⁽⁵⁾	0.11	1.11	NA ⁽⁵⁾	NA ⁽⁵⁾	0.12	NA ⁽⁵⁾
Day 20	NA	0.31	0.35	0.01	0.06	0.07	0.18	0.35	0.31	0.24	1.7

TABLE 4-38
NEANTHES ARENACEODENTATA TOXICITY TEST RESULTS AND ASSOCIATED ANALYTICAL DATA
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Negative Control	2B-REF-EWSD01	2B-REF-EWSD02	2B-EWSD04 ⁽¹⁾	2B-EWSD09	2B-EWSD12	2B-EWSD15	2B-EWSD16	2B-EWSD18	2B-EWSD20	2B-EWSD24
Pore Water Chemistry (continued) ⁽³⁾ :											
pH											
Day 0	NA	7.7	7.0	7.5	NA ⁽⁵⁾	7.7	7.8	NA ⁽⁵⁾	NA ⁽⁵⁾	7.9	NA ⁽⁵⁾
Day 28	NA	6.7	3.5	8.0	8.3	8.2	8.3	8.2	8.0	8.3	8.4
Toxicity Test Results:											
Survival (percent):											
Replicate A	80	60	60	80	40	90	50	70	90	30	60
Replicate B	80	40	30	90	30	70	80	80	90	60	40
Replicate C	80	80	20	50	10	60	100	60	100	70	50
Replicate D	90	80	70	80	30	80	100	90	90	50	40
Replicate E	80	50	50	90	30	100	90	70	100	60	80
Replicate F	90	100	80	100	10	100	100	100	100	60	40
Replicate G	70	100	70	90	10	80	100	70	90	60	50
Replicate H	90	80	40	100	50	90	100	100	90	40	40
Mean	82.50	73.75	52.50	85.00	26.25	83.75	90.00	80.00	93.75	53.75	50.00
Growth (dry weight per surviving polychaete per replicate in milligrams):											
Replicate A	0.3875	5.7333	3.9167	5.0875	2.1750	4.0444	3.0200	3.9571	3.8111	3.6000	4.2667
Replicate B	1.1500	5.3500	3.6333	4.6111	3.2333	3.5286	6.0125	4.2000	5.7667	3.0167	4.1500
Replicate C	1.5125	4.9000	3.8000	4.8200	4.7000	2.7500	4.8500	4.1000	4.5600	3.5571	6.9000
Replicate D	3.0889	3.4375	3.5000	4.6750	2.6333	3.3500	5.8800	4.6556	4.3222	3.4600	6.4250
Replicate E	2.3125	6.6000	4.0600	6.0111	2.3667	4.5900	9.9111	5.8714	6.1000	3.7333	6.9875
Replicate F	3.7111	2.9200	4.3750	6.1400	9.5000	4.6800	6.0600	6.1600	5.9400	3.4000	5.3000
Replicate G	2.8286	4.8200	3.3000	6.6778	4.1000	5.2625	6.8600	4.7286	5.4444	4.2333	7.1000
Replicate H	2.3111	3.9750	2.9000	6.1400	2.1800	3.5667	8.6600	4.3000	6.9444	2.4750	7.2250
Mean	2.1628	4.7170	3.6856	5.5203	3.8610	3.9715	6.4067	4.7466	5.3611	3.4344	6.0443

Notes:

Underline indicates endpoint is significantly different than 2B-REF-EWSD01 ($\alpha = 0.05$) as determined by a multiple comparison method (i.e., Bonferroni t-test)
Italics indicates endpoint is significantly different than 2B-REF-EWSD02 ($\alpha = 0.05$) as determined by a multiple comparison method (i.e., Bonferroni t-test)
Shading indicates an adverse effect (i.e., significantly lower survival, significantly greater weight loss, or significantly lower reproduction than polychaetes exposed to reference sediments)

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.
U = The analyte was analyzed for, but not detected at the reported sample quantitation limit
UJ = The analyte was analyzed for, but not detected at the reported sample quantitation limit; The reported sample quantitation limit is qualified as estimated

NA = Not analyzed
mg/L = milligram per liter
mg/kg = milligram per kilogram
< = less than

AVS = Acid Volatile Sulfide
SEM = Simultaneously Extracted Metals
ppt = parts per thousand

⁽¹⁾ The sample was duplicated in the field. Maximum reported copper, lead, mercury, and zinc concentrations in the original sample or duplicate sample are shown.
⁽²⁾ Analyses were performed by the analytical laboratory (Severn Trent laboratories, Inc.).
⁽³⁾ Analyses were performed by the toxicity testing laboratory (Fort Environmental Laboratories, Inc.).
⁽⁴⁾ For a given sediment treatment, pH analyses were performed on overlying water at test initiation (day 0) and on days 1, 2, 3, 4, 5, 13, and 20 of the toxicity tests. Salinity, total ammonia and sulfide analyses also were performed on overlying water at test initiation (day 0) and on days 5, 13, and 20 of the toxicity tests. Results of the pH, salinity, total ammonia, and sulfide measurements conducted on overlying water on days 2, 3, 4, 5, and 13 of the toxicity tests are presented within the testing laboratory's toxicity report (see Appendix B).
⁽⁵⁾ The sample lacked sufficient pore water to conduct the analysis.

TABLE 4-39
CORRELATION COEFFICIENT AND COEFFICIENT OF DETERMINATION VALUES: POLYCHAETE
SURVIVAL VERSUS SEDIMENT, OVERLYING WATER, AND PORE WATER VARIABLES
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Variable	Polychaete Survival		
	Correlation Coefficient Value (unitless)	Coefficient of Determination Value (unitless)	Significant at Alpha = 0.05 (Yes/No)
Ecological COCs:			
Copper	0.1807	0.0326	No
Lead	-0.0813	0.0066	No
Mercury	0.0588	0.0035	No
Zinc	-0.3260	0.1062	No
Physical/Chemical Properties:			
AVS/SEM	-0.6721	0.4518	Yes
Ammonia	0.2288	0.0524	No
Sulfide	0.4605	0.2120	No
pH	-0.0794	0.0063	No
TOC	0.2302	0.0530	No
Percent gravel	-0.3569	0.1274	No
Percent sand	-0.6669	0.4447	Yes
Percent fines	0.6177	0.3816	No
Overlying Water Chemistry ⁽¹⁾:			
Salinity	0.3685	0.1358	No
Ammonia	0.2586	0.0669	No
pH	-0.2544	0.0647	No
Pore Water Chemistry ⁽³⁾:			
Salinity (day 28)	0.0557	0.0031	No
Ammonia (day 28)	-0.3874	0.1501	No
Sulfide (day 28)	-0.2705	0.0732	No
pH (day 28)	0.1936	0.0375	No

Notes:

TOC = Total Organic Carbon

COC = Chemical of Concern

⁽¹⁾ Overlying and pore water measurements were conducted by the toxicity testing laboratory.

⁽²⁾ No regression was performed on sulfide concentrations in overlying water due to low intra- and inter-replicate variability throughout the toxicity tests.

⁽³⁾ No regression was performed on pore water parameters at test initiation since four SWMU 2 estuarine wetland sediment samples lacked sufficient pore water to conduct the analyses.

TABLE 4-40
SWMU 2 FIDDLER CRAB TISSUE DATA: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	2B-FCO1	2B-FCO2	2B-FCO3	2B-FCO4	2B-FCO5	2B-FCO6	2B-FCO7	2B-FCO8
Sampling Date	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007
Wetland Section	Section No. 4	Section No. 4	Section No. 3	Section No. 3	Section No. 2	Section No. 2	Section No. 1	Section No. 1
<u>Wet Weight Basis:</u>								
Metals (mg/kg)								
Lead	0.22 J	0.59	4.1	4.1	0.45	0.25 J	0.086 U	0.12 J
Mercury	0.016 J	0.0082 J	0.035	0.08	0.022	0.014 J	0.015 J	0.017 J
<u>Dry Weight Basis ⁽¹⁾:</u>								
Metals (mg/kg)								
Lead	0.85 J	2.3	16	16	1.7	0.96 J	0.33 U	0.46 J
Mercury	0.062 J	0.032 J	0.13	0.31	0.085	0.054 J	0.058 J	0.065 J
Lipids (percent)	0.095	0.01 U	1.4	0.01 U	1.0	0.79	0.49	0.01 U

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

mg/kg = milligram per kilogram

⁽¹⁾ For a given fiddler crab tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by 0.26 (estimated solids content of crabs with shells [USEPA, 1993]).

Table References:

United States Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

TABLE 4-41
ESTUARINE WETLAND REFERENCE AREA FIDDLER CRAB TISSUE DATA: BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	2B-REF-FC01	2B-REF-FC02	2B-REF-FC03	2B-REF-FC04
Sampling Date	5/21/2007	5/21/2007	5/21/2007	5/21/2007
<u>Wet Weight Basis:</u>				
Metals (mg/kg)				
Lead	0.28	0.1 J	0.26 J	0.091 U
Mercury - 7471A (mg/Kg)	0.014 J	0.021	0.008 J	0.013 J
<u>Dry Weight Basis ⁽¹⁾:</u>				
Metals (mg/kg)				
Lead	1.1	0.38 J	1.0 J	0.35 U
Mercury	0.054 J	0.081	0.031 J	0.05 J
Lipids (percent)	0.17	0.93	0.93	0.77

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

mg/kg = milligram per kilogram

⁽¹⁾ For a given fiddler crab tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by 0.26 (estimated solids content of crabs with shells [USEPA, 1993]).

Table References:

United States Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

TABLE 4-42
SUMMARY OF 95 PERCENT UPPER CONFIDENCE LIMIT OF THE MEAN HAZARD QUOTIENT VALUES FOR SPOTTED
SANDPIPER DIETARY EXPOSURES TO LEAD AND MERCURY IN SWMU 2 ESTUARINE WETLAND SEDIMENT
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values ⁽¹⁾		
	NOAEL	MATC	LOAEL
Metals:			
Lead	3.68	2.60	1.84
Mercury	1.45	0.84	0.48

Shaded cells indicate a Hazard Quotient (HQ) greater than 1.0.

Notes:

NOAEL = No Observed Adverse Effect Level

LOAEL = Lowest Observed Adverse Effect Level

MATC = Maximum Acceptable Toxicant Concentration

⁽¹⁾ Risk estimates (i.e., HQ values) were estimated using 95 percent UCL of the mean sediment and fiddler crab tissue concentrations.

TABLE 4-43
SWMU 2 TURTLE GRASS TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-SG01	2B-SG01	2B-SG02	2B-SG02	2B-SG03	2B-SG03
Sample ID	2B-SG01-AG	2B-SG01-WP	2B-SG02-AG	2B-SG02-WP	2B-SG03-AG	2B-SG03-WP
Sampling Date	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007

Wet Weight Basis:

Metals (mg/kg)

Arsenic	0.49	0.36 J	0.42 J	0.34 J	0.49	0.43 J
Cadmium	0.034 J	0.029 J	0.023 J	0.024 J	0.021 J	0.024 J
Copper	1.6	1.1	1.1	1.1	1.1	0.91
Lead	0.18 J	0.09 U	0.12 J	0.097 J	0.21 J	0.18 J
Mercury	0.0037 U	0.0034 U	0.0036 U	0.0037 U	0.0039 U	0.0037 U
Selenium	0.089 U	0.09 U	0.088 U	0.089 U	0.088 U	0.089 U
Zinc	8.6	5.1	6.5	5.3	5.8	5.0

General Chemistry

Moisture (percent)	85	85	82	85	83	86
--------------------	----	----	----	----	----	----

Dry Weight Basis ⁽¹⁾:

Metals (mg/kg)

Arsenic	7.4	5.4 J	7.6 J	5.1 J	8.3	6.0 J
Cadmium	0.51 J	0.44 J	0.41 J	0.36 J	0.36 J	0.34 J
Copper	24	17	20	17	19	13
Lead	2.7 J	1.4 U	2.2 J	1.5 J	3.6 J	2.5 J
Mercury	0.056 U	0.051 U	0.065 U	0.056 U	0.066 U	0.052 U
Selenium	1.3 U	1.4 U	1.6 U	1.3 U	1.5 U	1.2 U
Zinc	129	77	117	80	99	70

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit

U = The analyte was analyzed for, but not detected above the reported sample quantitation limit

TABLE 4-43
SWMU 2 TURTLE GRASS TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY WEIGHT BASIS): BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

mg/kg = milligram per kilogram

- ⁽¹⁾ For a given turtle grass tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by the solids fraction of the sample.

TABLE 4-44
OPEN WATER REFERENCE AREA NO. 2 TURTLE GRASS TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY
WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF2-VEG-AB01	REF2-VEG-WB01	REF2-VEG-AB02	REF2-VEG-WB02	REF2-VEG-AB03	REF2-VEG-WB03
Sample ID	REF2-VEG-AB01	REF2-VEG-WB01	REF2-VEG-AB02	REF2-VEG-WB02	REF2-VEG-AB03	REF2-VEG-WB03
Sampling Date	1/31/2007	1/31/2007	1/31/2007	1/31/2007	1/31/2007	1/31/2007

Wet Weight Basis:

Metals (mg/kg)

Arsenic	0.31 J	0.36 J	0.2 J	0.38 J	0.33 J	0.35 J
Cadmium	0.038 J	0.029 J	0.026 J	0.09 U	0.037 J	0.03 J
Copper	0.65	0.49	0.57	0.45 U	0.62	0.48
Lead	0.17 J	0.28 U	0.29 U	0.12 J	0.28 U	0.27 U
Mercury	0.019 U	0.02 U	0.019 U	0.018 U	0.019 U	0.02 U
Selenium	0.48 U	0.46 U	0.48 U	0.45 U	0.46 U	0.45 U
Zinc	4.2	3.7 U	3.8 U	3.6 U	4.3	3.6 U

General Chemistry

Moisture (percent)	86	87	85	89	84	84
--------------------	----	----	----	----	----	----

Dry Weight Basis⁽¹⁾:

Metals (mg/kg)

Arsenic	2.2 J	2.8 J	1.3 J	3.5 J	2.1 J	2.2 J
Cadmium	0.27 J	0.22 J	0.17 J	0.82 U	0.23 J	0.19 J
Copper	4.6	3.8	3.8	4.1 U	3.9	3.0
Lead	1.2 J	2.2 U	1.9 U	1.1 J	1.8 U	1.7 U
Mercury	0.14 U	0.2 U	0.13 U	0.16 U	0.12 U	0.13 U
Selenium	3.4 U	3.5 U	3.2 U	4.1 U	2.9 U	2.8 U
Zinc	30	28 U	25 U	33 U	27	23 U

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit

U = The analyte was analyzed for, but not detected above the reported sample quantitation limit

TABLE 4-44
OPEN WATER REFERENCE AREA NO. 2 TURTLE GRASS TISSUE ANALYTICAL RESULTS (WET WEIGHT AND DRY
WEIGHT BASIS): BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

mg/kg = milligram per kilogram

- ⁽¹⁾ For a given turtle grass tissue sample, dry weight concentrations were derived by dividing the wet weight concentrations reported by the analytical laboratory by the solids fraction of the sample.

TABLE 4-45
SWMU 2 CO-LOCATED OPEN WATER SEDIMENT ANALYTICAL RESULTS: BASELINE
ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	2B-OWSD01	2B-OWSD02	2B-OWSD02D	2B-OWSD03
Sample ID	2B-OWSD01	2B-OWSD02	2B-OWSD02D	2B-OWSD03
Sampling Date	5/22/2007	5/22/2007	5/22/2007	5/22/2007
Sample Depth (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)				
Arsenic	9.7 J	6.2 J	8.1 J	7.6 J
Cadmium	0.065 J	0.042 UJ	0.056 J	0.047 J
Copper	35 J	14 J	16 J	18 J
Lead	3.8 J	2.6 J	3.2 J	4.2 J
Mercury	0.027 J	0.017 J	0.018 J	0.015 J
Selenium	0.49 J	0.36 J	0.35 J	0.32 J
Zinc	22 J	19 J	23 J	24 J
General Chemistry				
TOC (mg/kg)	48,000	49,000	40,000	53,000
Grain Size (percent)				
Gravel	0.0	0.0	NA	0.0
Sand	31.6	45.7	NA	36.1
Coarse Sand	1.5	1.5	NA	3.8
Medium Sand	2.4	2.2	NA	3.4
Fine Sand	27.8	42	NA	31.8
Fines (silt/clay)	68.4	54.3	NA	60.9

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

NA = Not Analyzed

TOC = Total Organic Carbon

mg/kg = milligram per kilogram

bgs = below ground surface

TABLE 4-46
OPEN WATER REFERENCE AREA NO. 2 CO-LOCATED SEDIMENT ANALYTICAL
RESULTS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	REF2-VEG-SED01	REF2-VEG-SED02	REF2-VEG-SED03
Sample ID	REF2-VEG-SED01	REF2-VEG-SED02	REF2-VEG-SED03
Sampling Date	4/30/2007	4/30/2007	4/30/2007
Sample Depth (feet bgs)	0.0-0.5	0.0-0.5	0.0-0.5
Metals (mg/kg)			
Arsenic	21	1.1	0.96
Cadmium	0.046 J	0.14 U	0.17 U
Copper	4.9 J	1.6	1.4 J
Lead	5.5 J	1.5 J	0.58 J
Mercury	0.041 U	0.032 U	0.035 U
Selenium	0.21 J	0.72 U	0.87 U
Zinc	7.3 J	2.1 J	1.7 J
General Chemistry			
TOC (mg/kg)	29,000	13,000	30,000
Grain Size (percent)			
Gravel	2.4	1.6	0.6
Sand	72.2	82.5	79.6
Coarse Sand	2.7	6.2	6.3
Medium Sand	14.3	35.2	27
Fine Sand	55.2	41	46.4
Silt	10.7	8	13.2
Clay	14.7	7.9	6.5

Notes:

J = The analyte was positively identified; however, the concentration value is an estimate; Also used if a result was measured at a concentration below the Contract Required Quantitation Limit or Contract Required Detection Limit.

U = The analyte was analyzed for, but not detected at the reported sample quantitation limit

TOC = Total Organic Carbon

mg/kg = milligram per kilogram

bgs = below ground surface

TABLE 4-47
MAXIMUM HAZARD QUOTIENT VALUES FOR WEST INDIAN MANATEE DIETARY
EXPOSURES TO ECOLOGICAL CHEMICALS OF CONCERN IN SWMU 2 OPEN WATER SEDIMENT
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Hazard Quotient Values ⁽¹⁾		
	NOAEL	MATC	LOAEL
Metals:			
Arsenic	0.65	0.52	0.41
Cadmium	0.12	0.04	0.01
Copper	0.20	0.15	0.12
Lead	0.09	0.03	<0.01
Mercury	0.64	0.50	0.38
Selenium	0.79	0.64	0.52
Zinc	0.63	0.20	0.06

Notes:

NOAEL = No Observed Adverse Effect Level

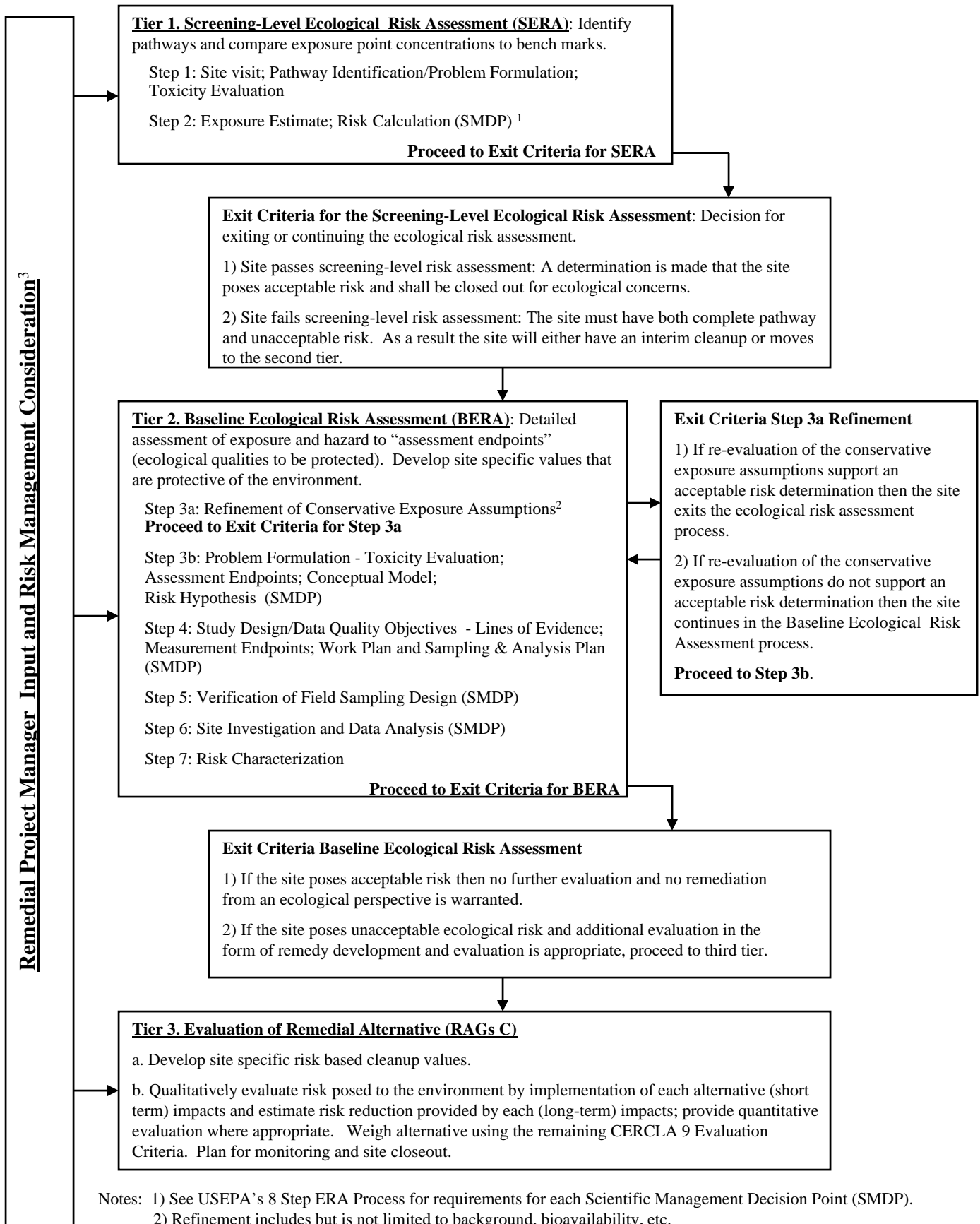
LOAEL = Lowest Observed Adverse Effect level

MATC = Maximum Acceptable Toxicant Concentration

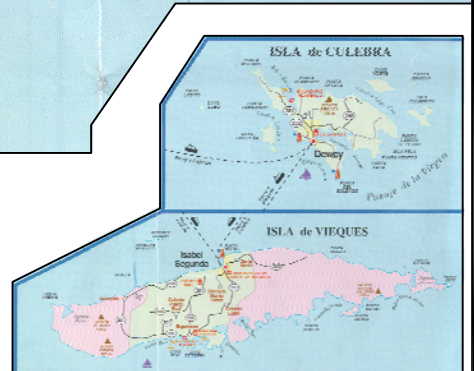
⁽¹⁾ Risk estimates (i.e., hazard quotient values) were derived using maximum sediment and turtle grass tissue concentrations.

FIGURES

Figure 1-1
Navy Ecological Risk Assessment Tiered Approach

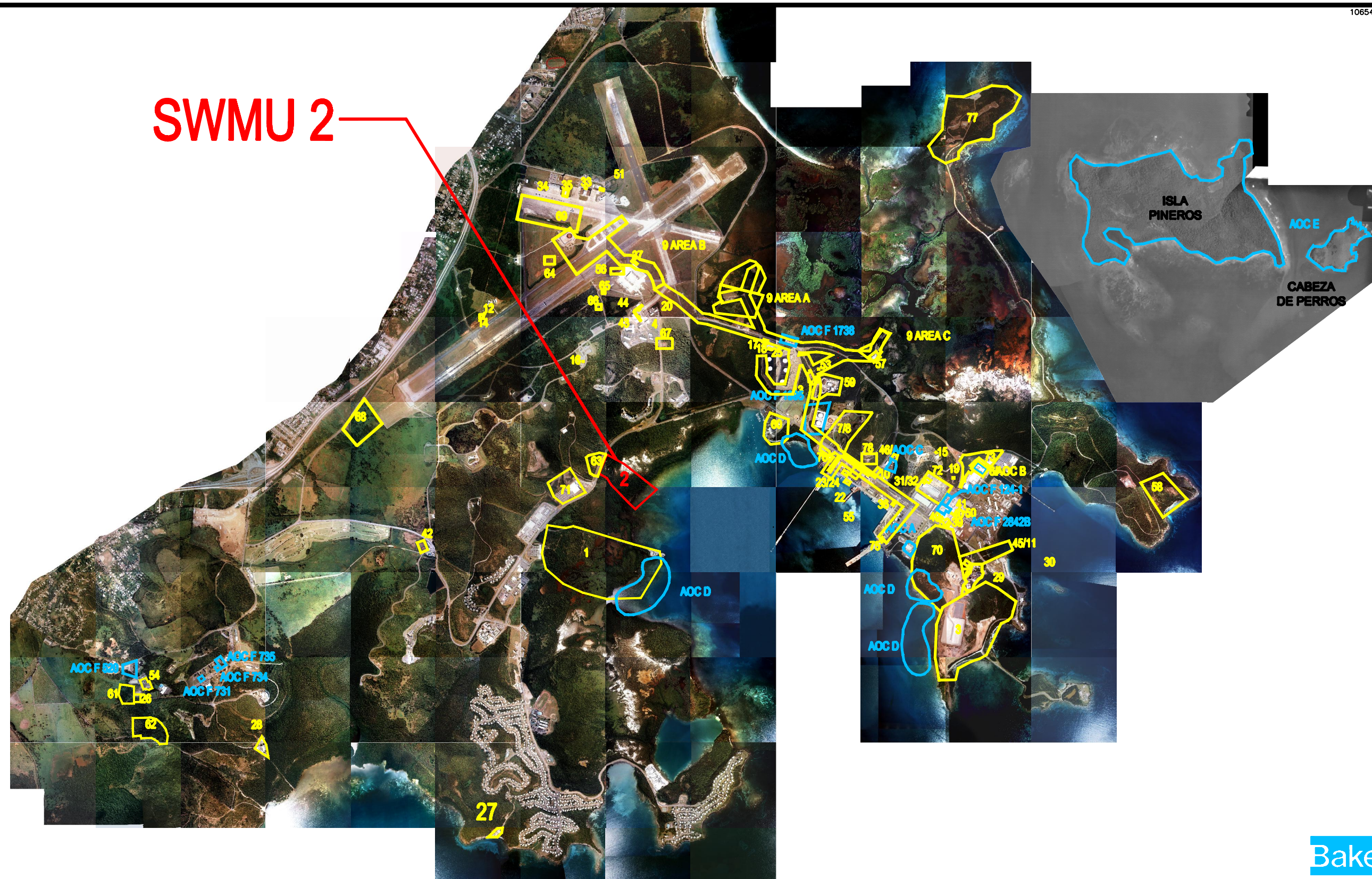


Notes: 1) See USEPA’s 8 Step ERA Process for requirements for each Scientific Management Decision Point (SMDP).
2) Refinement includes but is not limited to background, bioavailability, etc.
3) Risk management is incorporated throughout the tiered approach.



NAVAL ACTIVITY PUERTO RICO

SWMU 2



Baker

LEGEND

-  - SWMUs
 - AREA TO WHICH THIS INVESTIGATION PERTAINS
 - AOCs

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

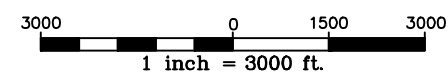
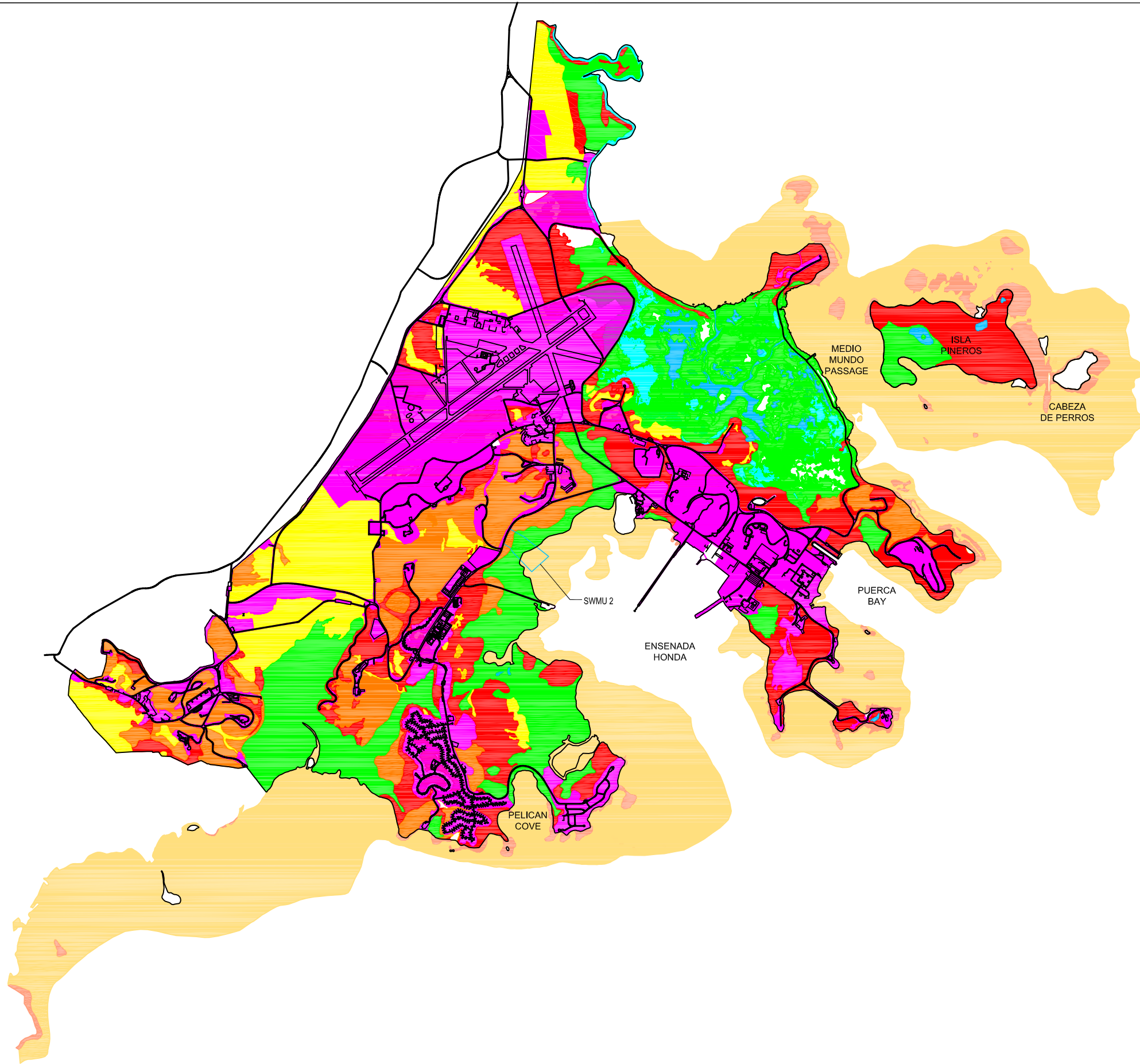


FIGURE 2-2
 SWMU/AOC LOCATION MAP
 SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
 STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
 NAVAL ACTIVITY PUERTO RICO



- LEGEND**
- COASTAL SCRUB FOREST
 - CORAL
 - GRASSLAND/WET MEADOW
 - MANGROVE
 - SEAGRASS
 - SHALLOW FLAT
 - UPLAND COASTAL FOREST
 - URBAN
 - WATER

SOURCE: GEO-MARINE, INC.

REVISIONS

DRAWN /RRR
REVIEWED MEK
S.O.# 106547
CADD# 106547_02_03.DWG

NORTH

SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
NAVAL ACTIVITY PUERTO RICO

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker

TERRESTRIAL AND AQUATIC HABITAT OCCURRING
AT NAVAL ACTIVITY PUERTO RICO
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL
RISK ASSESSMENT

SCALE 1" = 2000'

DATE JUNE 2009

FIGURE

2-3



1500 0 700 1500
1 inch = 1500 ft.

Baker
Michael Baker Jr., Inc.

LEGEND



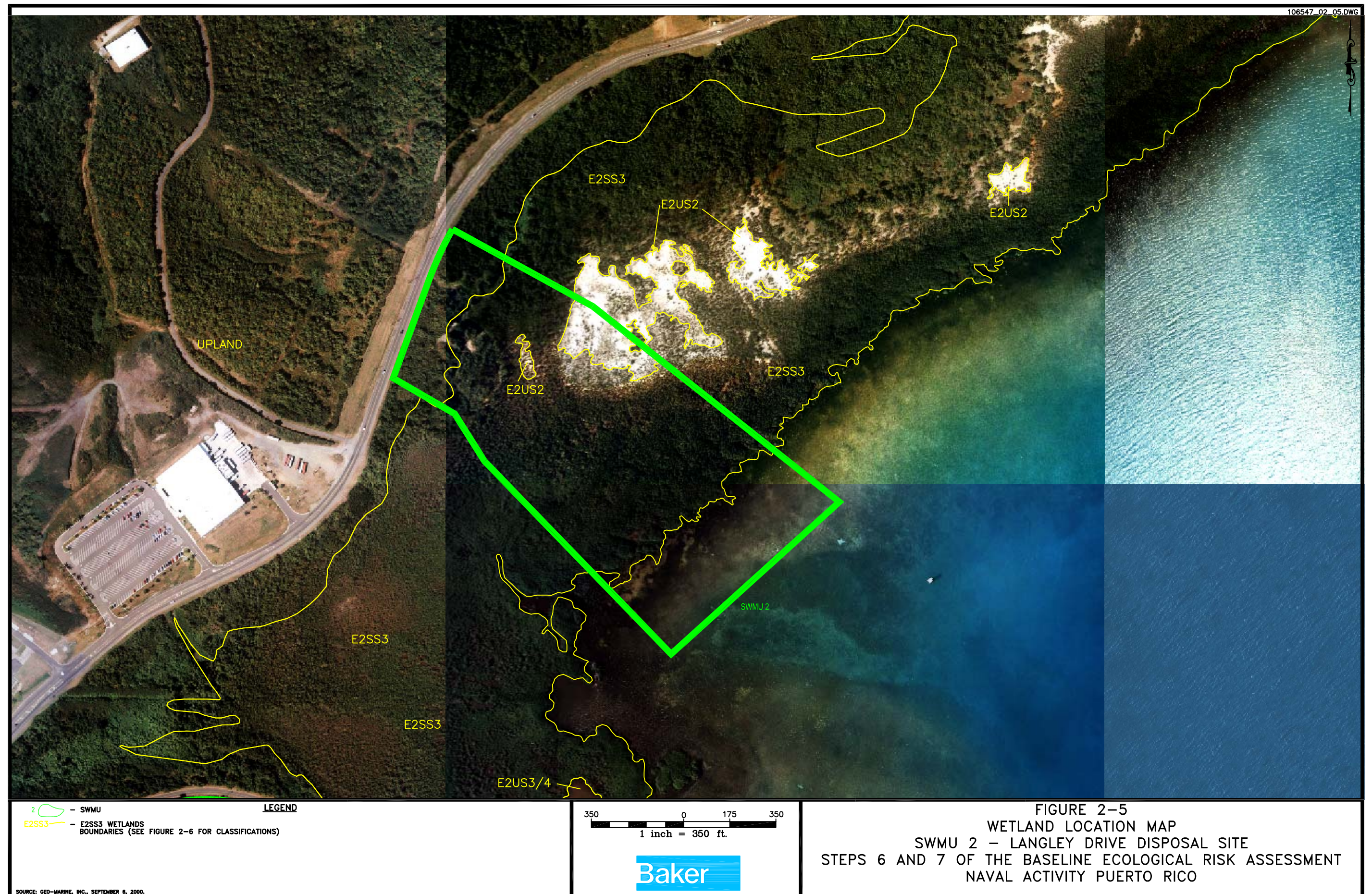
-  - APPROX. LOCATION OF COBANA NEGRA
-  - AREA TO WHICH THIS INVESTIGATION PERTAINS

FIGURE 2-4
APPROXIMATE LOCATION OF
COBANA NEGRA
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE
ECOLOGICAL RISK ASSESSMENT

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

NAVAL ACTIVITY PUERTO RICO

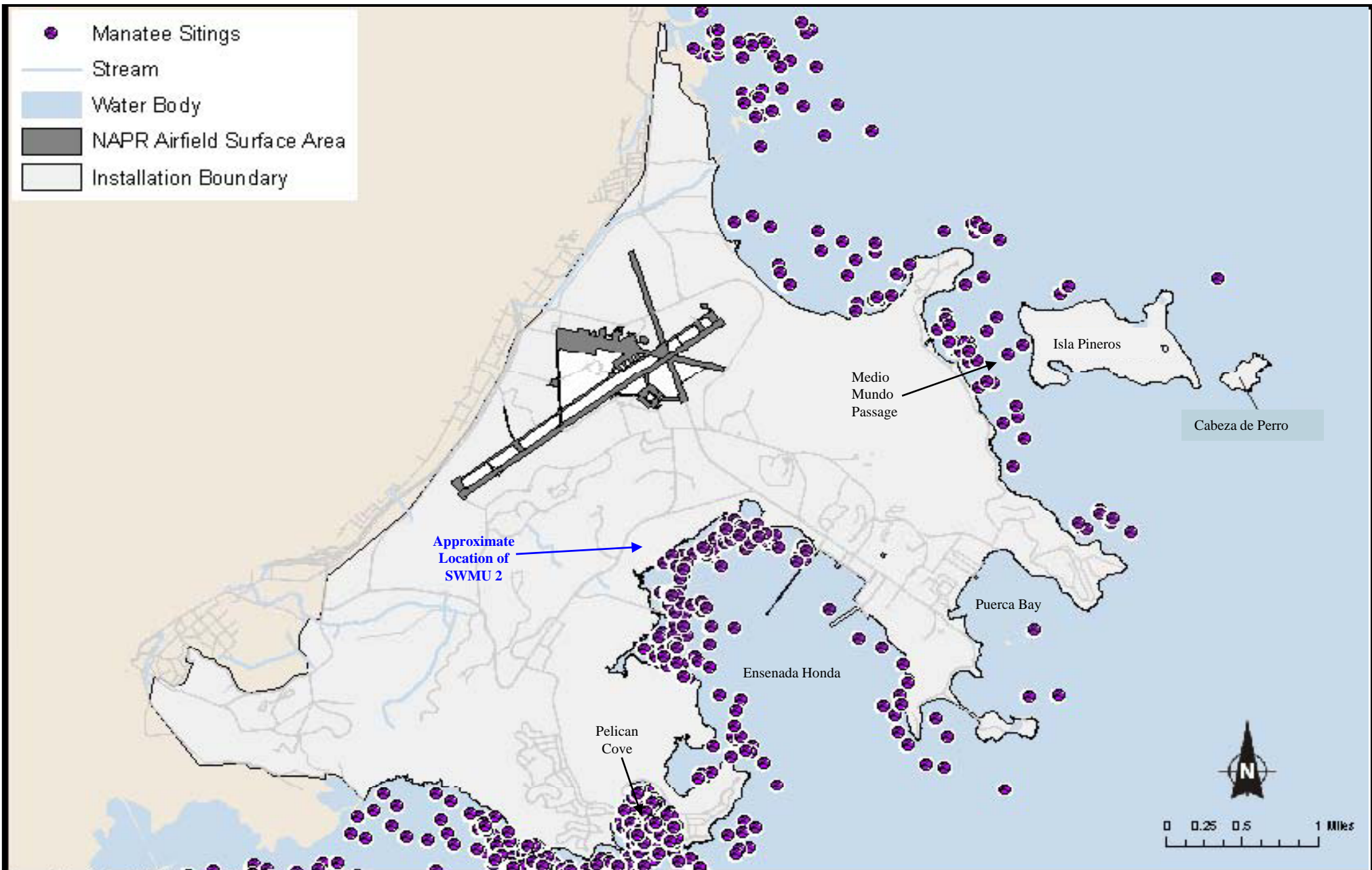


SYSTEM		M - MARINE										E - ESTUARINE									
SUBSYSTEM		1 - SUBTIDAL					2 - INTERTIDAL					1 - SUBTIDAL					2 - INTERTIDAL				
CLASS	RB - Rock Bottom UB - Unconsolidated Bottom	AB - Aquatic Bed	RF - Reef	OW - Open Water (unknown bottom)	AB - Aquatic Bed	RF - Reef	RS - Rocky Shore	US - Unconsolidated Shore	RB - Rock Bottom UB - Unconsolidated Bottom	AB - Aquatic Bed	RF - Reef	OW - Open Water (unknown bottom)	AB - Aquatic Bed	RF - Reef	SB - Streambed	RS - Rocky Shore	US - Unconsolidated Shore	EN - Emergent	SS - Scrub-Shrub	FO - Forested	
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vasc 5 Unknown	1 Coral 3 Worm	1 Algal 3 Rooted Vasc 5 Unknown	1 Coral 3 Worm	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vasc 4 Floating Vasc 5 Unknown Submerg. 6 Unknown Surface	2 Mollusk 3 Worm	1 Algal 3 Rooted Vasc 4 Floating Vasc 5 Unknown Submerg. 6 Unknown Surface	2 Mollusk 3 Worm	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Dead	1 Persistent 2 Nonpersistent	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 Deciduous 7 Evergreen	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 Deciduous 7 Evergreen	
SYSTEM		R - RIVERINE										L - LACUSTRINE									
SUBSYSTEM		1 - TIDAL	2 - LOWER PERENNIAL	3 - UPPER PERENNIAL	4 INTERMITTENT	5 - UNKNOWN PERENNIAL	1 - LIMNETIC	2 - LITTORAL													
CLASS	RB - Rock UB - Unconsolidated Bottom	SB - Streambed	AB - Aquatic Bed	RS - Rocky Shore	US - Unconsolidated Shore	OW - Open Water (unknown bottom)	**EM - Emergent	RB - Rock Bottom OW - Open Water (unknown bottom)	RS - Rocky Shore	UB - Unconsolidated Bottom	AB - Aquatic Bed	US - Unconsolidated Shore	EN - Emergent	OW - Open Water (unknown bottom)							
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble 3 Cobble - Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 Unknown Submerg. 6 Unknown Surface	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	2 Nonpersistent	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 Unknown Submerg. 6 Unknown Surface	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent							
SYSTEM		P - PALUSTRINE										MODIFIERS									
CLASS	RB - Rock Bottom UB - Unconsolidated Bottom	AB - Aquatic Bed	US - Unconsolidated Shore	ML - Moss-Lichen	EM - Emergent	SS - Scrub-Shrub	FO - Forested	OW - Open Water (unknown bottom)													
Subclass	1 Bedrock 2 Rubble	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 Unknown Submerg. 6 Unknown Surface	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 Deciduous 7 Evergreen	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 Deciduous 7 Evergreen		WATER REGIME		WATER CHEMISTRY				SOIL		SPECIAL				
	A Temp. Flooded B Saturated C Seasonally Flooded D Seasonally Flooded/ Well Drained E Seasonally Flooded/ Saturated F Semipermanently Flooded G Intermittently Exposed	H Permanently Flooded J Intermittently Flooded K Artificially Flooded M Irregularly Flooded N Regularly Flooded P Irregularly Flooded	Tidal *S Temporary-Tidal *R Seasonal-Tidal *T Semipermanent-Tidal *V Permanent-Tidal U Unknown	Coastal Halinity 1 Hyperhaline 2 Euhaline 3 Microhaline 4 Polyhaline 5 Mesohaline 6 Oligohaline 0 Fresh	Inland Salinity 7 Hypersaline 8 Euhaline 9 Mixosaline 0 Fresh	pH(fresh water) a Acid t circumneutral i Alkaline	g Organic n Mineral	b Beaver d partially drained/ditched f Farmed h Diked/Impounded r Artificial Substrate s Spoil x Excavated	* These water regimes are only used in tidally influenced, freshwater systems.												

SOURCE: UNITED STATES, FISH AND WILDLIFE SERVICE. CLASSIFICATION OF WETLANDS AND DEEPWATER HABITATS OF THE UNITED STATES, 1985

Baker

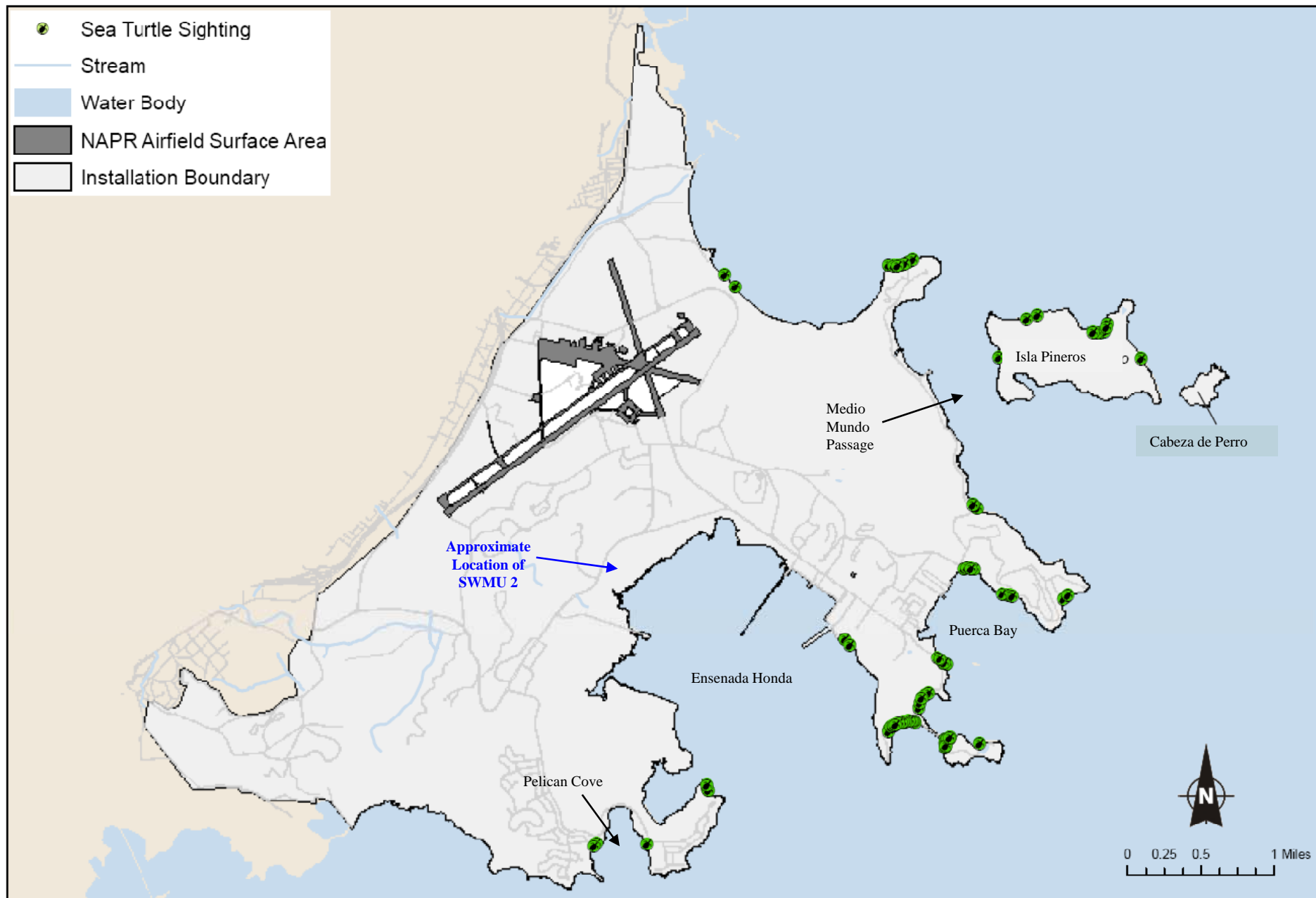
FIGURE 2-6
THE COWARDIN WETLAND CLASSIFICATION SYSTEM
SWMU 2 – LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO



Source: Geo-Marine, 2005; ESRI, 2004; US FWS, 2005;

Figure from: Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads)*. April 2007.

FIGURE 2-7
HISTORICAL MANATEE SIGHTINGS IN EASTERN PUERTO RICO
SWMU 2 – LANGLEY DRIVE DISPOSAL AREA
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

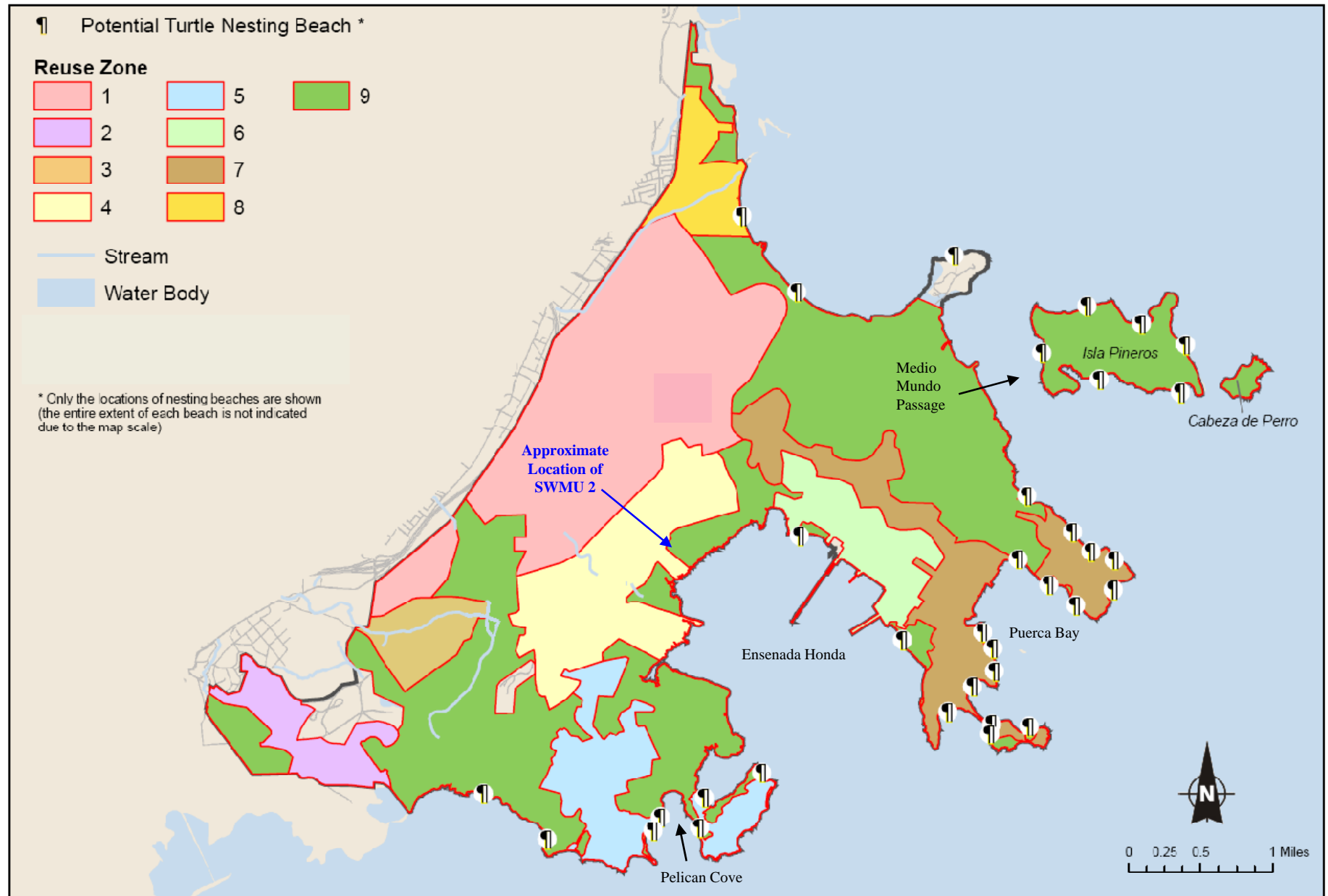


Source: Geo-Marine, 2005; ESRI, 2004; USFWS, 2005;

Cumulative sea turtle sightings from March 1984 through March 1995 obtained from weekly aerial surveys of the Former Naval station Roosevelt Roads.

Figure from: Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads)*. April 2007.

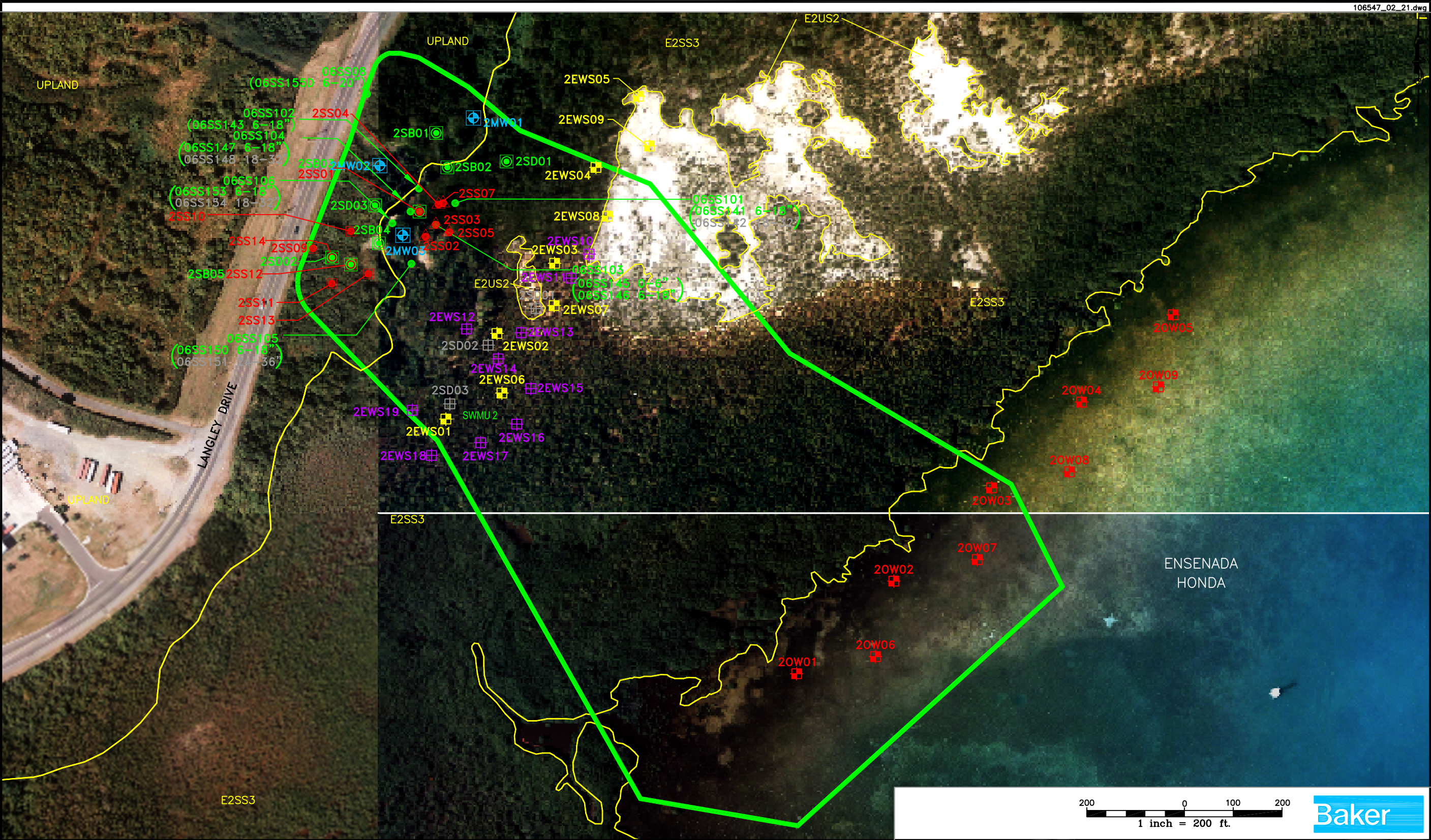
FIGURE 2-8
SEA TURTLE SIGHTINGS AT NAVAL ACTIVITY PUERTO RICO
SWMU 2 – LANGLEY DRIVE DISPOSAL AREA
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO



Source: Geo-Marine, 2005; FSRI, 2004;

Figure from: Department of Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads)*. April 2007

FIGURE 2-9
POTENTIAL TURTLE NESTING SITES
SWMU 2 – LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO



LEGEND

2 - SWMU

E2SS3 - E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)

⊞ - SEDIMENT SAMPLE LOCATION (RELATIVE RISK RANKING)

⊞ - MONITORING WELL/SURFACE SOIL SAMPLING LOCATION (1996 RFI)

● - SOIL SAMPLE LOCATION (SUPPLEMENTAL INVESTIGATION)

⊞ - SURFACE SOIL SAMPLE LOCATION (1996 RFI)

⊞ - SURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)

⊞ - SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)

ESTUARINE WETLAND SYSTEM

⊞ - SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION INVESTIGATION)

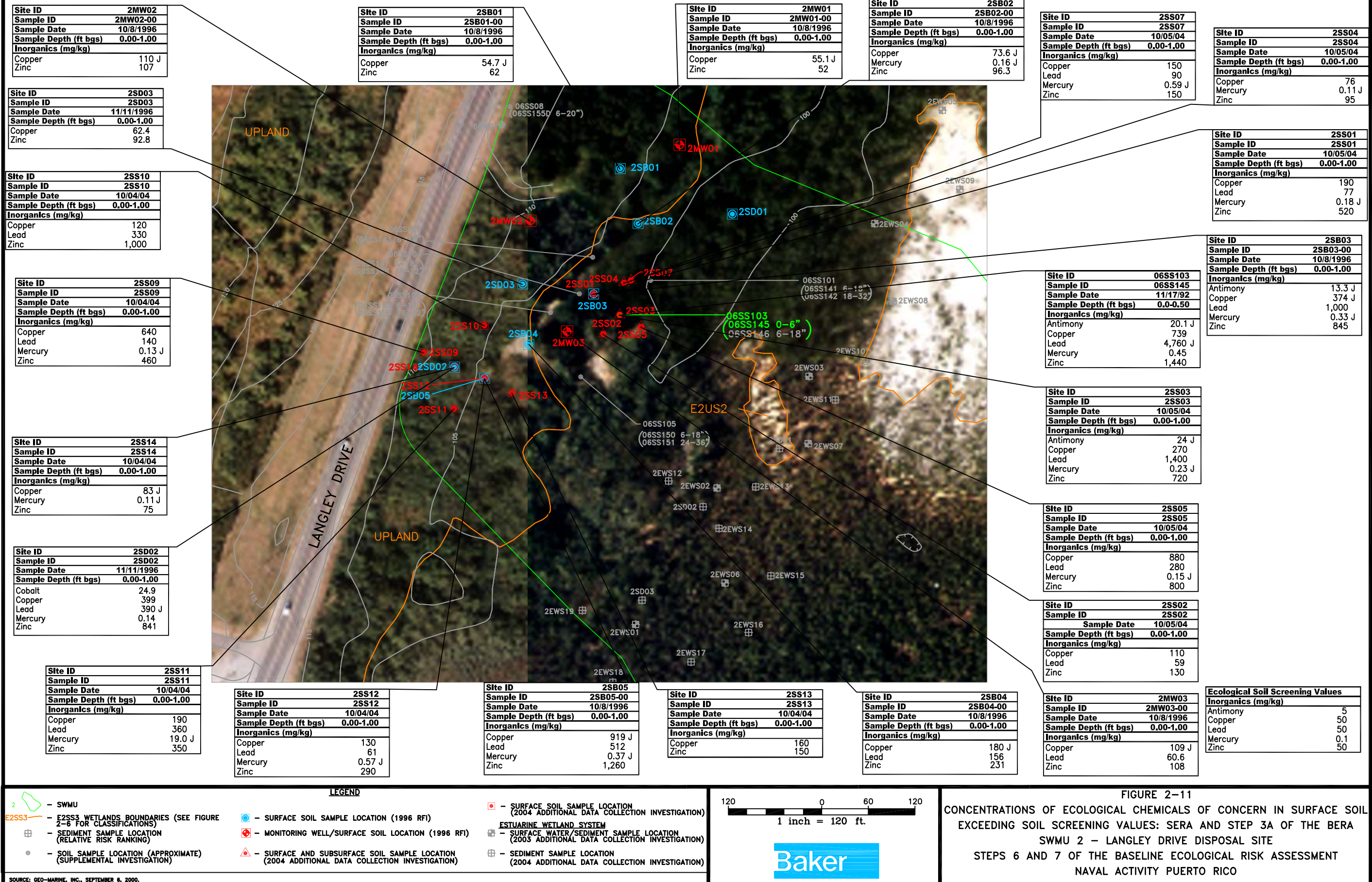
⊞ - SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)

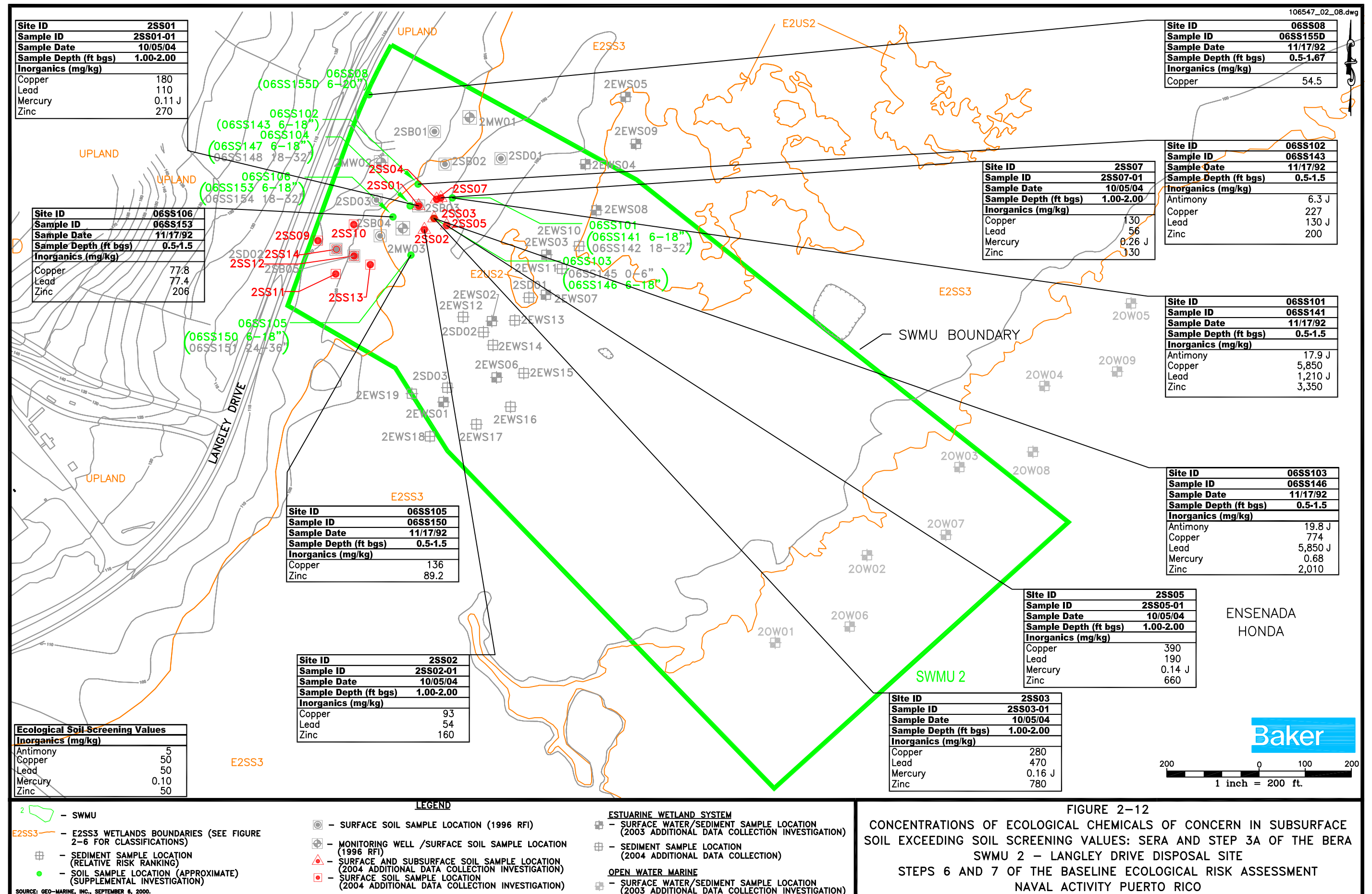
OPEN WATER MARINE

⊞ - SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION INVESTIGATION)

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

FIGURE 2-10
SOIL, SURFACE WATER, AND SEDIMENT SAMPLING LOCATIONS FOR ANALYTICAL DATA USED
IN THE SERA AND STEP 3A OF THE BERA
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO





Site ID	2EWS02
Sample ID	02EWSSD02
Sample Date	07/27/03
Sample Depth (ft bgs)	0.0 - 0.5
Inorganics (mg/kg)	
Copper	65

Site ID	2EWS12
Sample ID	2EWSD12
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	280 J
Lead	170

Site ID	2EWS06
Sample ID	02EWSSD06
Sample Date	07/27/03
Sample Depth (ft bgs)	0.0 - 0.5
Inorganics (mg/kg)	
Copper	69

Site ID	2EWS14
Sample ID	2EWSD14
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	180 J
Lead	59

Site ID	2EWS19
Sample ID	2EWSD19
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	150 J
Lead	31

Site ID	2EWS18
Sample ID	2EWSD18
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	130 J

Site ID	2EWS01
Sample ID	02EWSSD01
Sample Date	07/27/03
Sample Depth (ft bgs)	0.0 - 0.5
Inorganics (mg/kg)	
Copper	180
Lead	68

Site ID	2EWS17
Sample ID	2EWSD17
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	150 J

Site ID	2EWS16
Sample ID	2EWSD16
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	110 J
Lead	39

Site ID	2EWS04
Sample ID	02EWSSD04
Sample Date	07/27/03
Sample Depth (ft bgs)	0.0 - 0.5
Inorganics (mg/kg)	
Copper	20

Site ID	2EWS10
Sample ID	2EWSD10
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	36 J

Site ID	2EWS03
Sample ID	02EWSSD03
Sample Date	07/27/03
Sample Depth (ft bgs)	0.0 - 0.5
Inorganics (mg/kg)	
Copper	78

Site ID	2EWS11
Sample ID	2EWSD11
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	77 J

Site ID	2EWS07
Sample ID	02EWSSD07
Sample Date	07/27/03
Sample Depth (ft bgs)	0.0 - 0.5
Inorganics (mg/kg)	
Copper	20

Site ID	2EWS13
Sample ID	2EWSD13
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	88 J

Site ID	2EWS15
Sample ID	2EWSD15
Sample Date	10/04/04
Sample Depth (ft bgs)	0.0 - 0.33
Inorganics (mg/kg)	
Copper	54 J

Ecological Sediment Screening Criteria	
Inorganics (mg/kg)	
Copper	18.7
Lead	30.2

- 2 - SWMU
- E2SS3 - E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)
- ⊞ - SEDIMENT SAMPLE LOCATION (RELATIVE RISK RANKING)
- - SOIL SAMPLE LOCATION (APPROXIMATE) (SUPPLEMENTAL INVESTIGATION)
- SOURCE: GEO-MARINE, INC., SEPTEMBER 8, 2000.

- LEGEND
- ⊙ - SURFACE SOIL SAMPLE LOCATION (1996 RFI)
- ⊕ - MONITORING WELL/SURFACE SOIL SAMPLE LOCATION (1996 RFI)
- ⊡ - SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)
- ⊞ - SURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)

- ESTUARINE WETLAND SYSTEM
- ⊞ - SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION INVESTIGATION)
- ⊞ - SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)
- OPEN WATER MARINE 2004
- ⊞ - SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION INVESTIGATION)

200 0 100 200

1 inch = 200 ft.

Baker

FIGURE 2-13

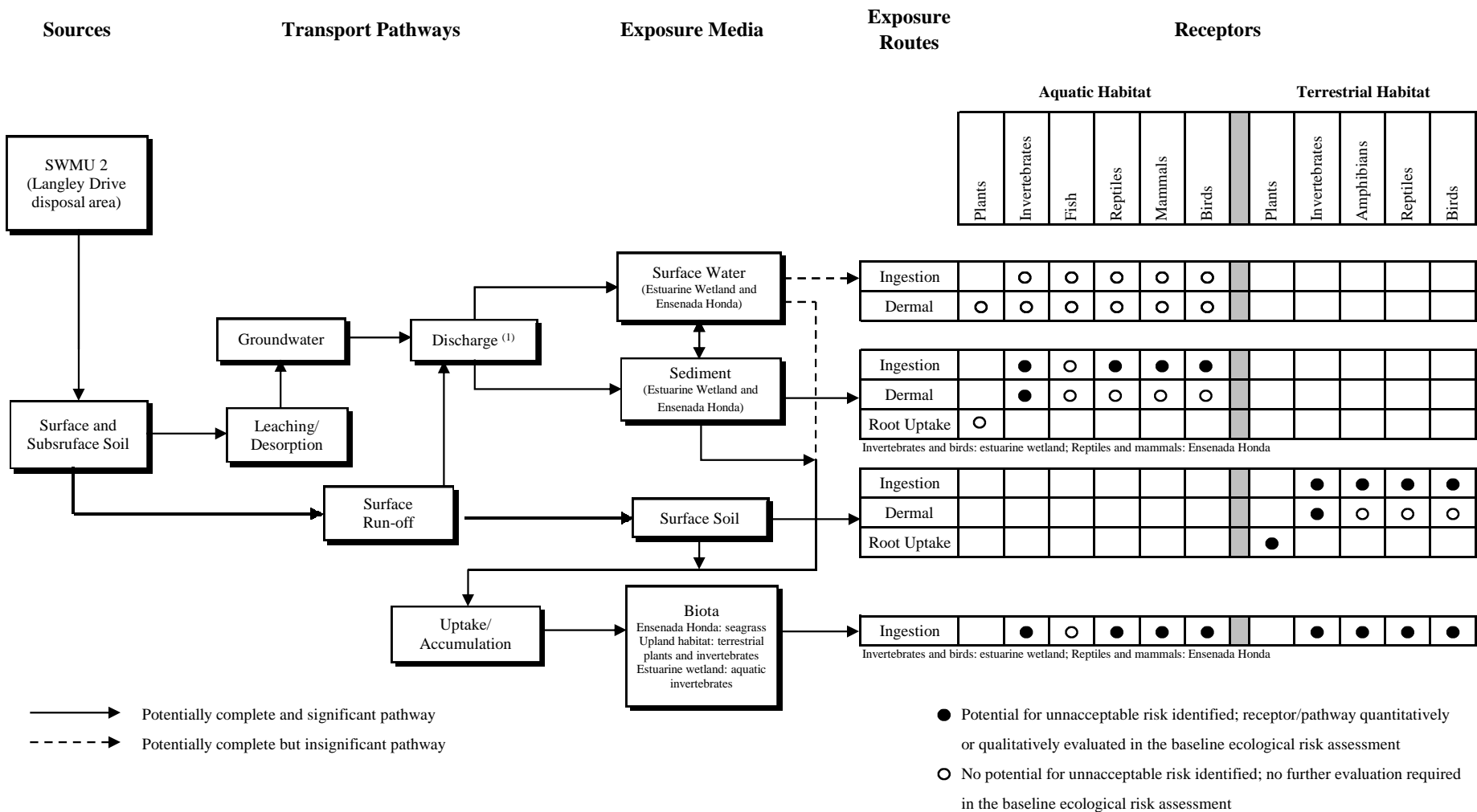
CONCENTRATIONS OF ECOLOGICAL CHEMICALS OF CONCERN IN ESTUARINE WETLAND SEDIMENT EXCEEDING SEDIMENT SCREENING VALUES: SERA AND 3A OF THE BERA

SWMU 2 - LANGLEY DRIVE DISPOSAL SITE

STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

NAVAL ACTIVITY PUERTO RICO

FIGURE 2-14
REFINED CONCEPTUAL MODEL
SWMU 2 - LANGLEY DRIVE DISPOSAL AREA
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO



⁽¹⁾ Surface run-off discharges only to the estuarine wetland portion of SWMU 2



106547_02_12.DWG

Baker

FIGURE 3-2

SWMU 2 AND UPLAND REFERENCE AREA SOIL SAMPLING LOCATIONS: VERIFICATION OF
THE FIELD SAMPLING DESIGN
SWMU 2 – LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

LEGEND

- 2 - SWMU 1 BOUNDARY
- E2SS3 - E2SS3 WETLANDS BOUNDARIES
- - REFERENCE SOIL SAMPLE LOCATION

600 0 300 600
1 inch = 600 ft.

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.



LEGEND

- SWMU 1 BOUNDARY
- E2SS3 WETLANDS BOUNDARIES
- REFERENCE SEDIMENT SAMPLE LOCATION

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

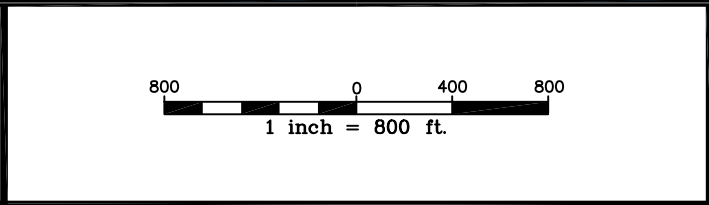


FIGURE 3-3
SWMU 2 AND ESTUARINE WETLAND REFERENCE AREA SEDIMENT SAMPLING LOCATIONS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO



LEGEND

● - OPEN WATER REFERENCE AREA SEDIMENT SAMPLING LOCATION

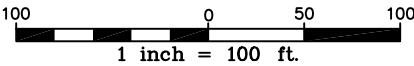


FIGURE 3-4

OPEN WATER REFERENCE AREA NO. 1 SEDIMENT SAMPLING LOCATIONS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.



LEGEND

- ⊙ - OPEN WATER REFERENCE AREA SEDIMENT SAMPLING LOCATION

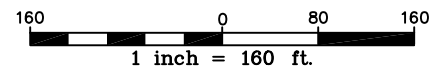
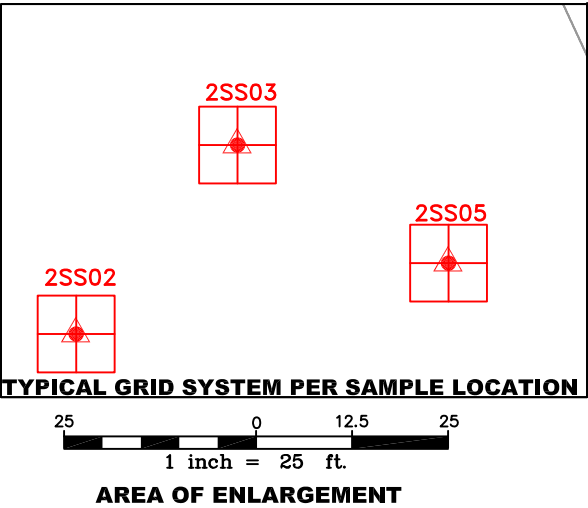
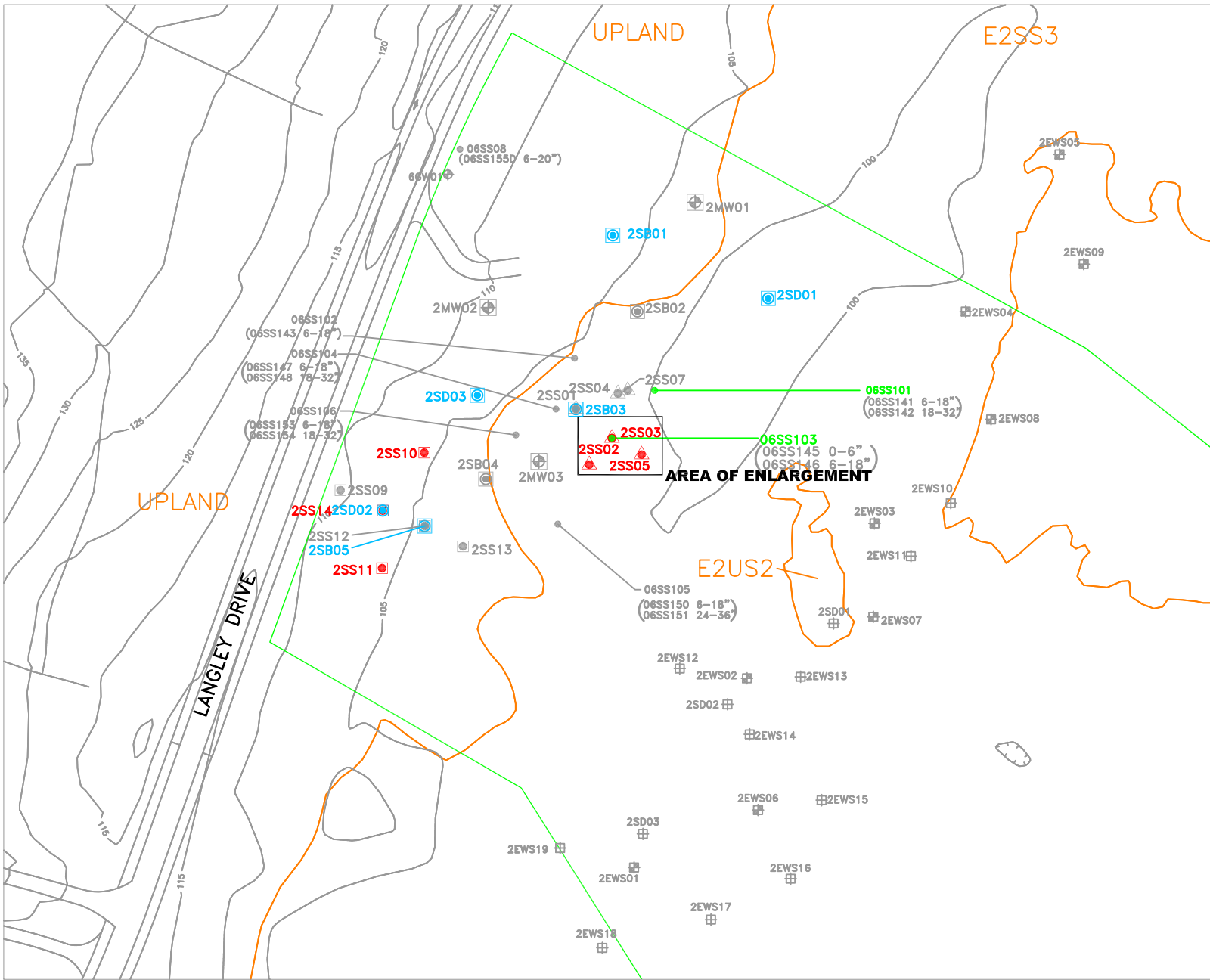


FIGURE 3-5

OPEN WATER REFERENCE AREA NOS. 2 AND 3 SEDIMENT SAMPLING LOCATIONS:
VERIFICATION OF THE FIELD SAMPLING DESIGN
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.



NOTE
PROPOSED SAMPLING LOCATIONS IN COLOR

LEGEND			
- SWMU	- SURFACE SOIL SAMPLE (1996 RFI)	- SURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)	
- E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)	- MONITORING WELL/SURFACE SOIL LOCATION (1996 RFI)	- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION INVESTIGATION)	
- SEDIMENT SAMPLE LOCATION (RELATIVE RISK RANKING)	- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)	- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)	
- SOIL SAMPLE LOCATION (APPROXIMATE) (SUPPLEMENTAL INVESTIGATION)			

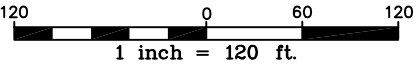


FIGURE 3-6
SWMU 2 SOIL SAMPLING LOCATIONS: BASELINE ECOLOGICAL RISK
ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO



106547_02_22.dwg

Baker

LEGEND

- 2 — SWMU 2 BOUNDARY
- E2SS3 — E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)
- — REFERENCE AREA SOIL SAMPLE LOCATON

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

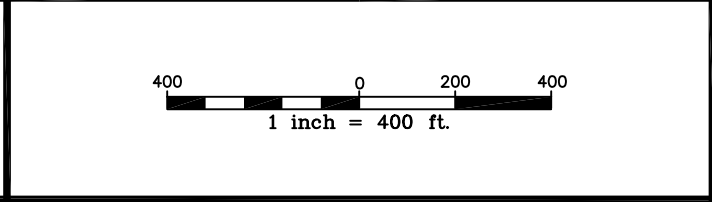
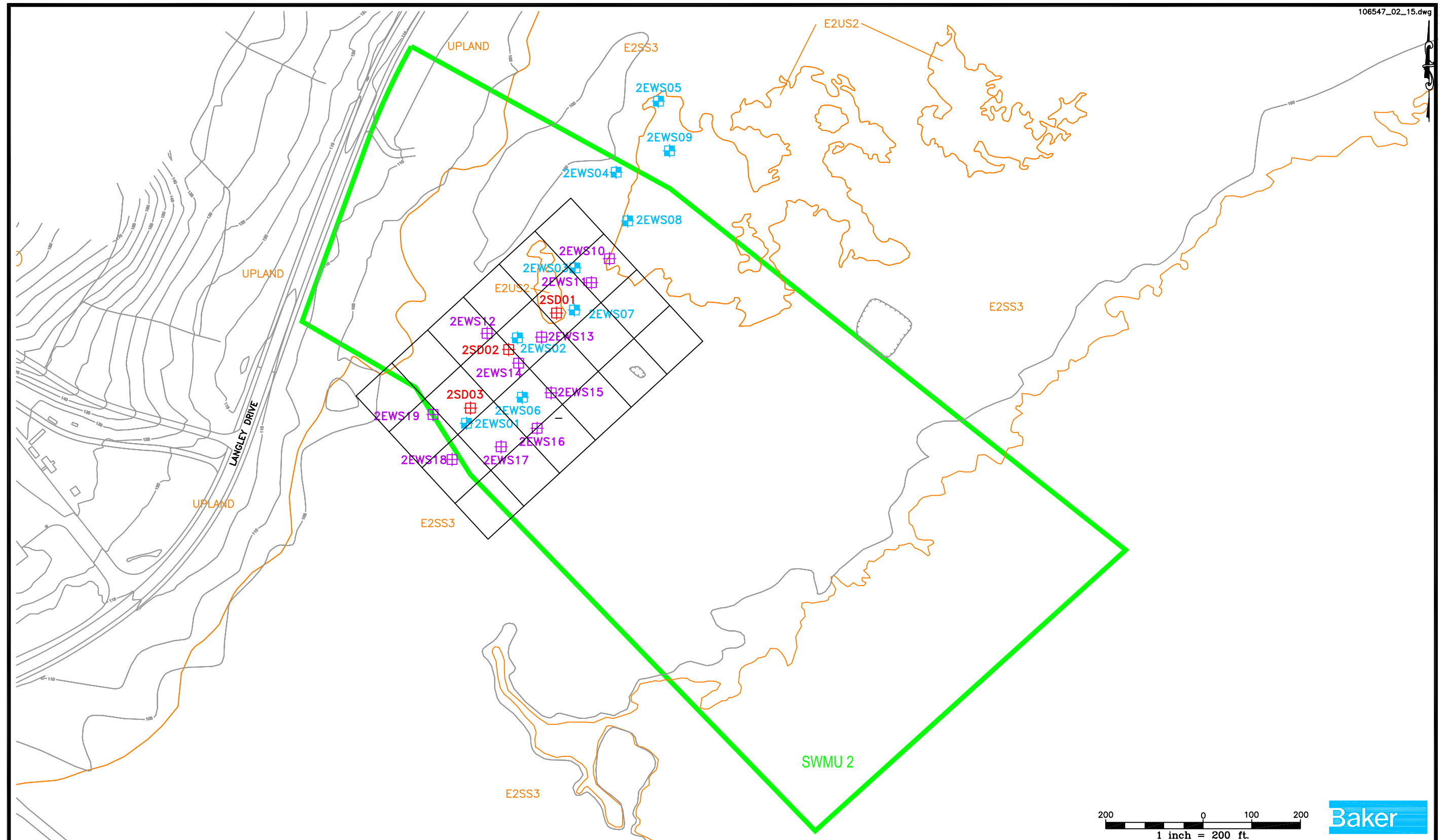


FIGURE 3-7

UPLAND REFERENCE AREA NO. 2 SOIL SAMPLING LOCATIONS:
BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 — LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO



LEGEND

	- SWMU		- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION INVESTIGATION)
	- E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)		- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)
	- SEDIMENT SAMPLE LOCATION (RELATIVE RISK RANKING)		

FIGURE 3-8

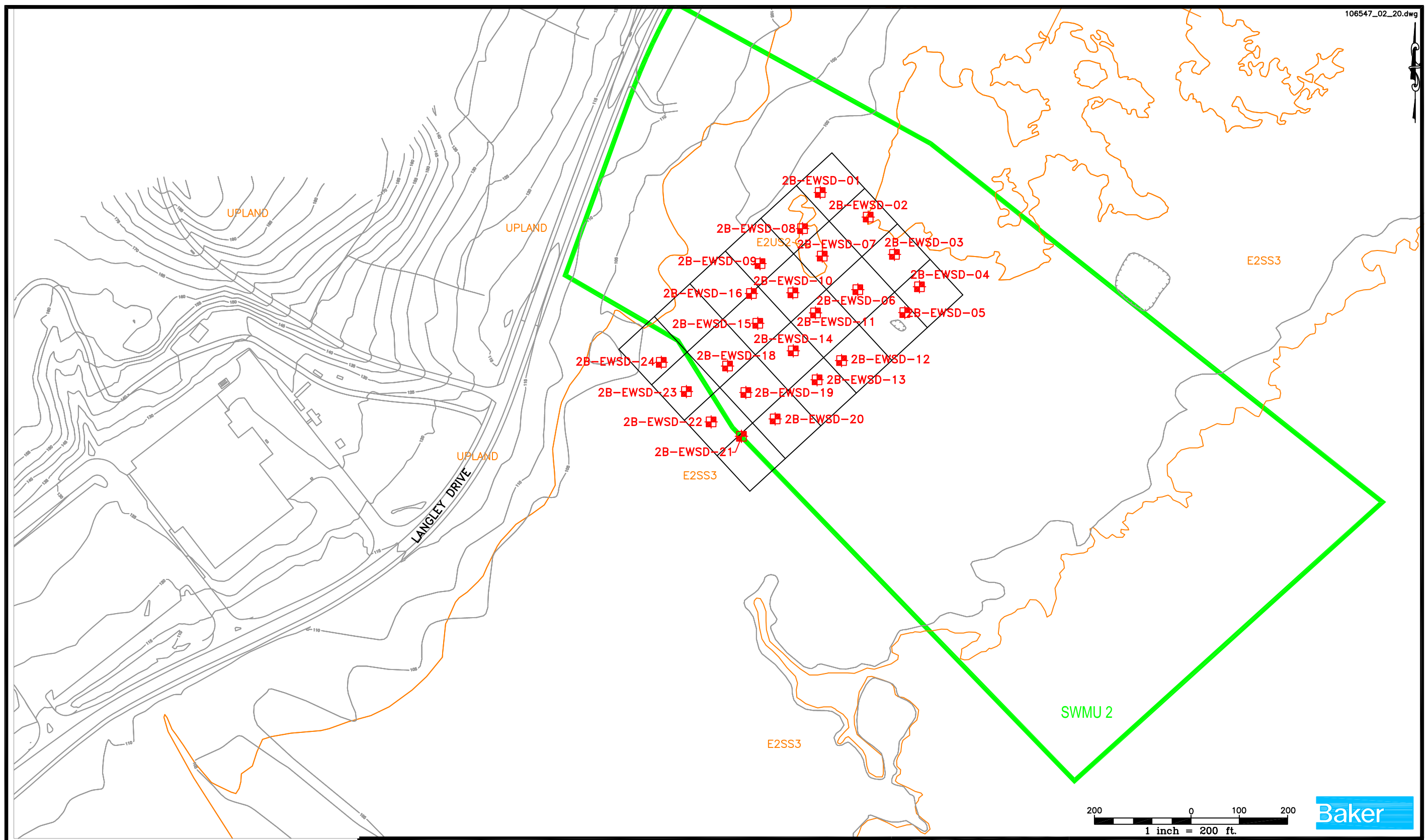
SWMU 2 ESTUARINE WETLAND SEDIMENT SAMPLING GRIDS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION

SWMU 2 - LANGLEY DRIVE DISPOSAL SITE

STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

NAVAL ACTIVITY PUERTO RICO

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.



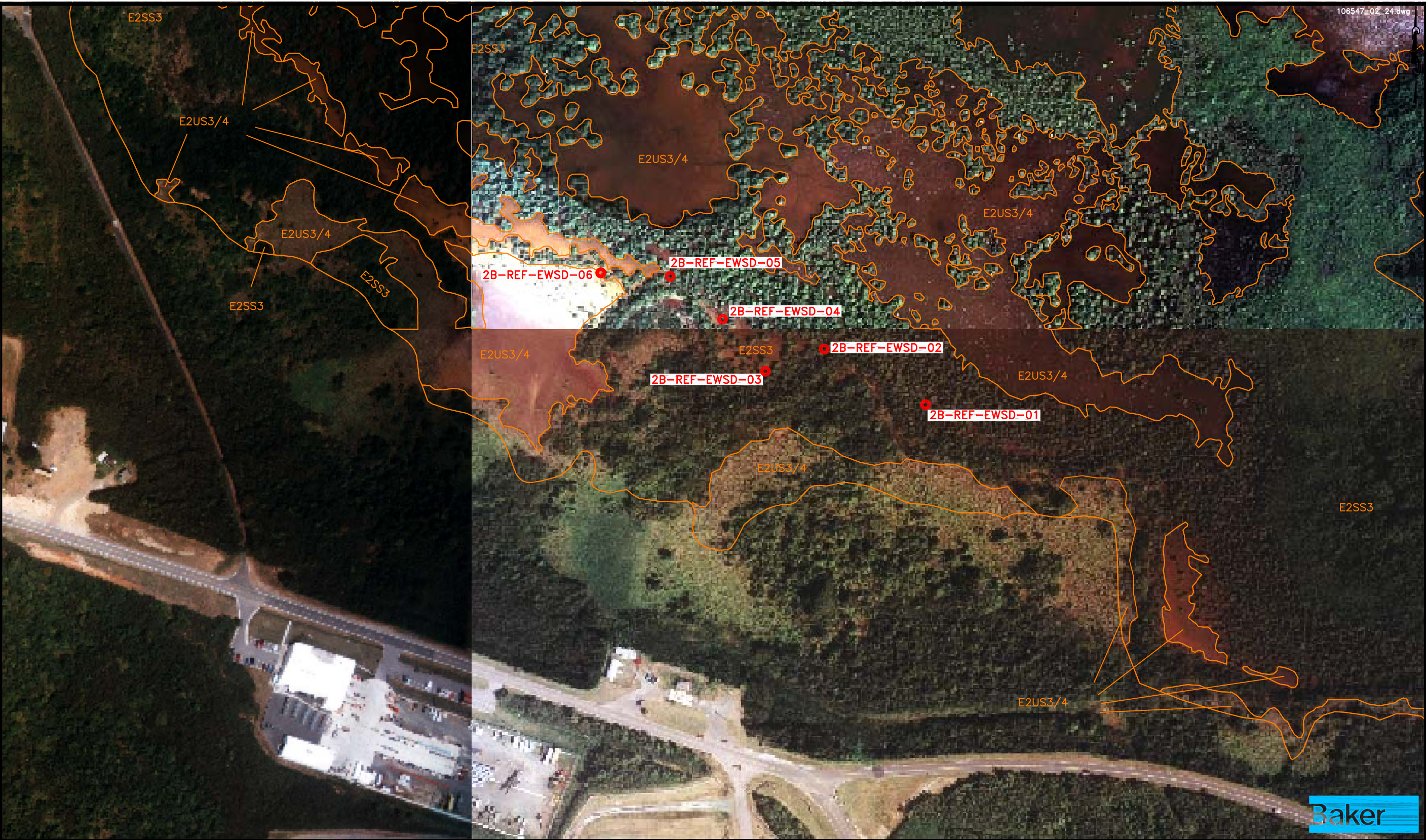
- LEGEND**
- 2 - SWMU
 - E2SS3 - E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)
 - - SEDIMENT SAMPLING LOCATION

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

FIGURE 3-9
SWMU 2 ESTUARINE WETLAND SEDIMENT SAMPLING LOCATIONS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO



200 0 100 200
1 inch = 200 ft.



LEGEND
E2SS3 — E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)
● — REFERENCE SOIL SAMPLE LOCATON

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

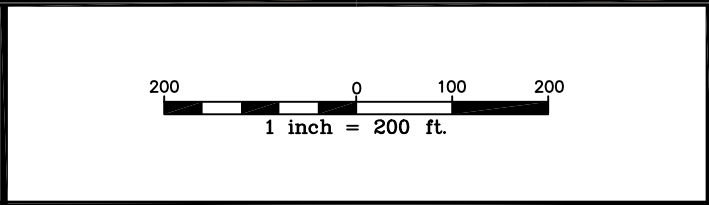
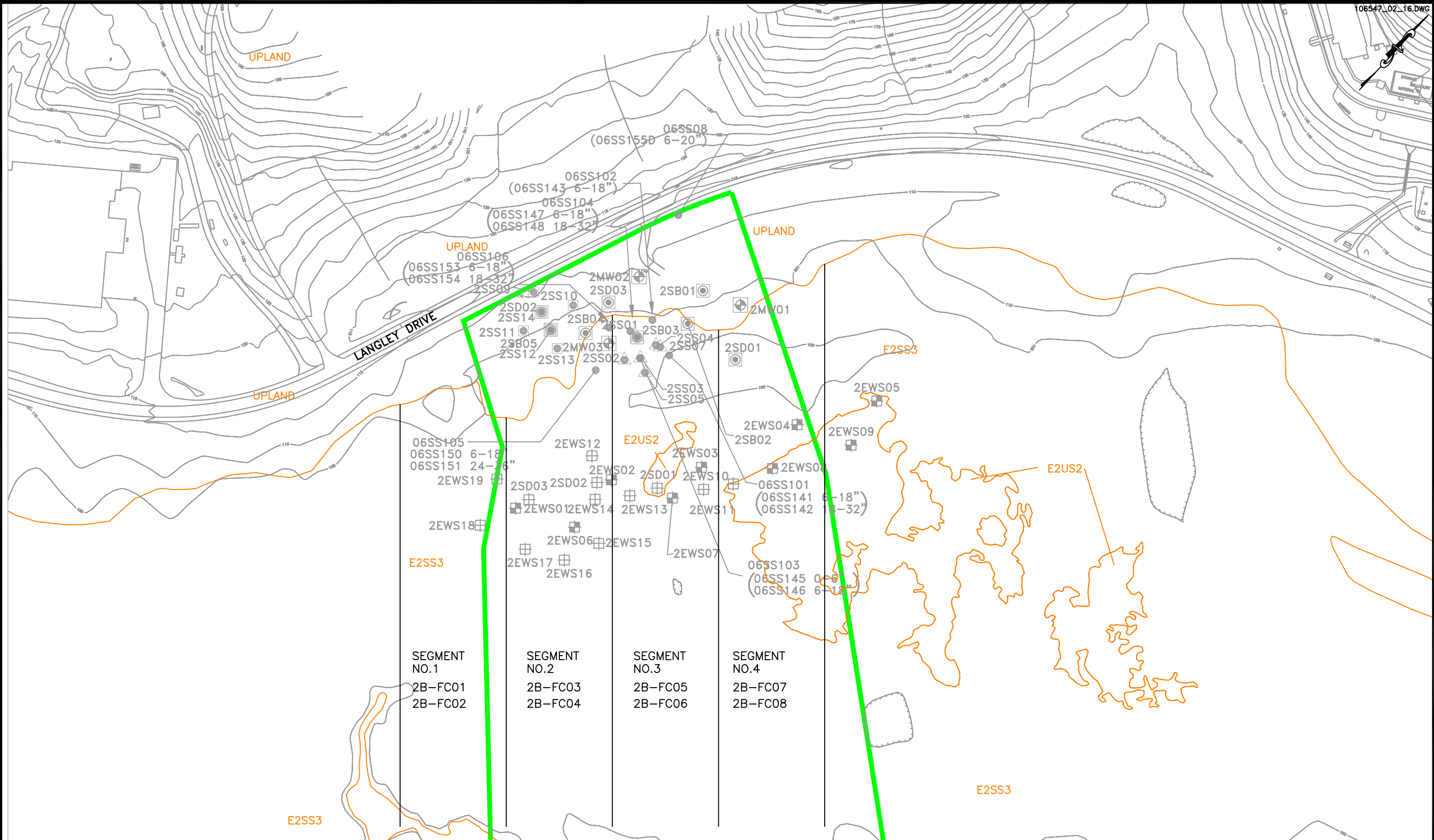


FIGURE 3-10
ESTUARINE WETLAND REFERENCE AREA SEDIMENT SAMPLING LOCATIONS:
BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 — LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO



LEGEND

- SWMU	- SURFACE SOIL SAMPLE LOCATION (1996 RFI)	- SURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)
- E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)	- MONITORING WELL/SURFACE SOIL LOCATION (1996 RFI)	- SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION INVESTIGATION)
- SEDIMENT SAMPLE LOCATION (RELATIVE RISK RANKING)	- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)	- SEDIMENT SAMPLE LOCATION (2004 ADDITIONAL DATA COLLECTION INVESTIGATION)
- SOIL SAMPLE LOCATION (APPROXIMATE) (SUPPLEMENTAL INVESTIGATION)		

200 0 100 200

1 inch = 200 ft.

Baker

FIGURE 3-11

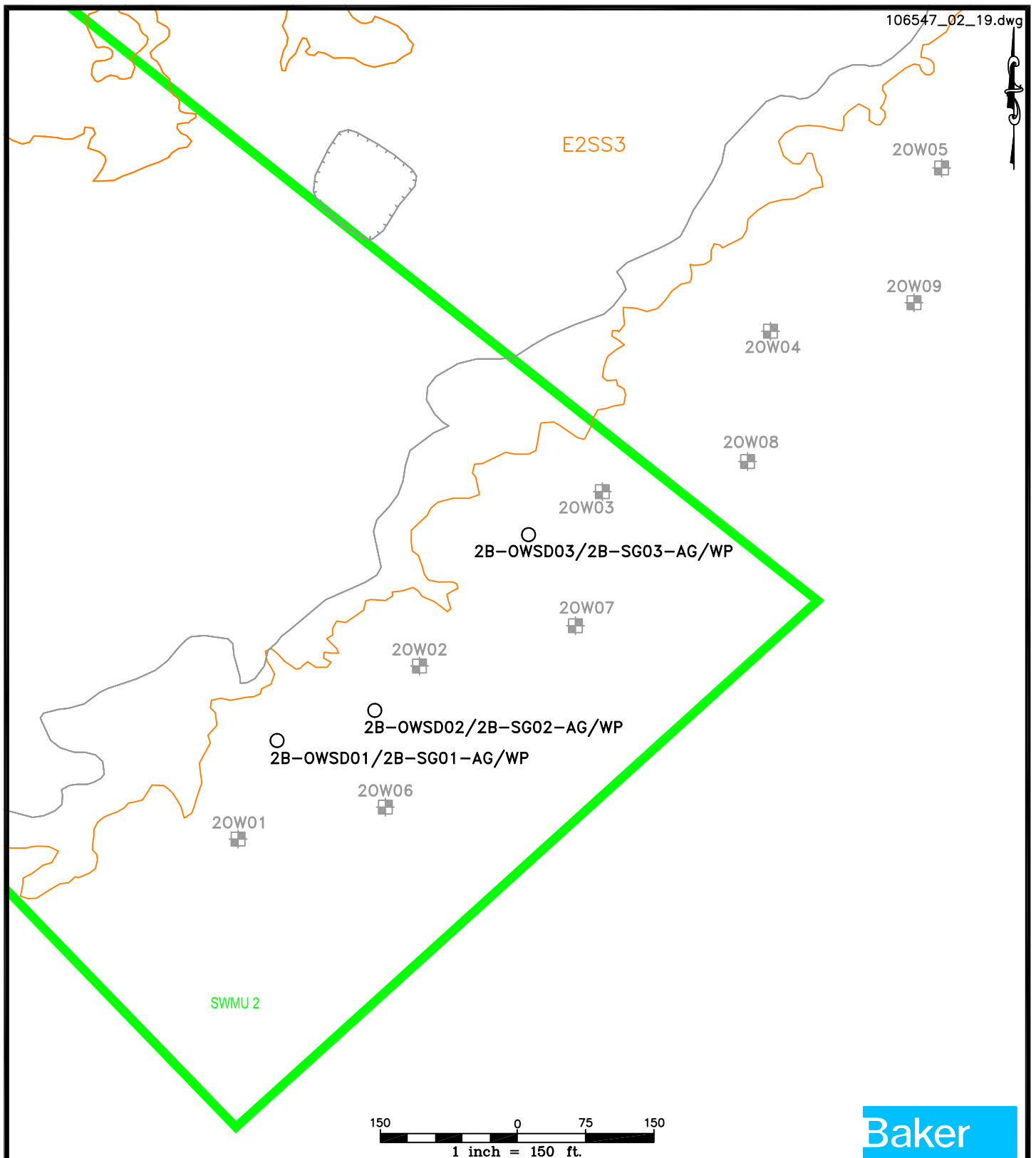
SWMU 2 ESTUARINE WETLAND FIDDLER CRAB TISSUE SAMPLING LOCATIONS:

BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION

SWMU 2 – LANGLEY DRIVE DISPOSAL SITE

STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

NAVAL ACTIVITY PUERTO RICO



LEGEND

2 - SWMU

E2SS3 - E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 2-6 FOR CLASSIFICATIONS)

○ - SEDIMENT/TURTLE GRASS SAMPLE LOCATION (BERA FIELD INVESTIGATION) OPEN WATER MARINE 2004

■ - SURFACE WATER/SEDIMENT SAMPLE LOCATION (2003 ADDITIONAL DATA COLLECTION INVESTIGATION)

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

FIGURE 3-12

SWMU 2 OPEN WATER TURTLE GRASS TISSUE AND CO-LOCATED SEDIMENT SAMPLING LOCATIONS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION

SWMU 2 - LANGLEY DRIVE DISPOSAL

SITE STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

NAVAL ACTIVITY PUERTO RICO



LEGEND

- ⑥ - OPEN WATER REFERENCE AREA SEAGRASS TISSUE AND SEDIMENT SAMPLING LOCATION

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

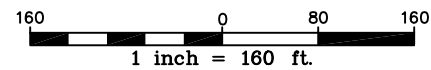


FIGURE 3-13

OPEN WATER REFERENCE AREA NO. 2 TURTLE GRASS TISSUE AND CO-LOCATED SEDIMENT SAMPLING LOCATIONS: BASELINE ECOLOGICAL RISK ASSESSMENT FIELD INVESTIGATION
SWMU 2 - LANGLEY DRIVE DISPOSAL SITE
STEPS 6 AND 7 OF THE BASELINE ECOLOGICAL RISK ASSESSMENT
NAVAL ACTIVITY PUERTO RICO

APPENDIX A
HABITAT CHARACTERIZATION OF SOLID WASTE
MANAGEMENT UNITS (SWMU) 1, SWMU 2, AND SWMU 45

**HABITAT CHARACTERIZATION OF SOLID WASTE
MANAGEMENT UNITS (SWMU) 1, SWMU 2, AND SWMU 45,
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO**

Prepared for:

CH2M Hill

Prepared by:

**Dr. Dan L. Wilkinson, Rudi Reinecke, Melissa Lopez-Rodriguez,
Manuel Figueroa-Pagan, and Donna DeYoung**

**Geo-Marine, Inc.
550 E. 15th Street
Plano, Texas 75074**

October 11, 2000

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION.....	1
SITE LOCATION.....	1
METHODS	1
RESULTS AND DISCUSSION.....	5
SWMU 1	5
Vegetation Community Description.....	5
Plant Community Health	6
Wildlife Description.....	10
Protected Species.....	10
Food Web.....	12
SWMU 2.....	14
Vegetation Community Description.....	14
Plant Community Health	14
Wildlife Description.....	15
Protected Species.....	15
Food Web.....	15
SWMU 45.....	19
Terrestrial Area.....	19
Vegetation Community Description.....	19
Plant Community Health	19
Wildlife Description.....	22
Protected Species.....	22
Food Web.....	22
Marine Area	22
CONCLUSION	23
LITERATURE CITED	24
APPENDIX A.....	A-1
APPENDIX B.....	B-1

LIST OF FIGURES

		<u>Page</u>
1	General Location of NAVSTA Roosevelt Roads, Puerto Rico.....	2
2	Location Map of SWMU 1, 2, and 45 Roosevelt Roads Puerto	3
3	Location of SWMU 1, Roosevelt Roads, Puerto Rico.....	7
4	SWMU 1, Red Mangrove Community (<i>Rhizophora mangle</i>) with Upland Coastal Forest in Background	8
5	SWMU 1, Coastal Scrub Forest Community.....	8
6	Generalized Food Web for the Upland Coastal Forest and Coastal Scrub Forest Communities at NAVSTA Roosevelt Roads.	13
7	Generalized Food Web for Mangrove Communities at NAVSTA Roosevelt Roads	13
8	Location of SWMU 2, Roosevelt Roads, Puerto Rico.....	17
9	SWMU 2, Un-maintained Road in Center of Photograph within the Upland Coastal Forest Community.....	18
10	SWMU 2, Typical Vegetation Showing Upland Coastal Forest Species	18
11	Location of SWMU 45, Roosevelt Roads, Puerto Rico.....	20
12	SWMU 45, Along the Shoreline of the Cove, Killdeer (<i>Charadrius vociferous</i>) Foraging Among Washed-up Seagrass	21

LIST OF TABLES

		<u>Page</u>
1	Federally Listed Species Occurring or Potentially Occurring at NAVSTA Roosevelt Roads.....	4
2	Vegetation Observed at SWMU 1	9
3	Wildlife Observed at SWMU 1	11
4	Vegetation Observed at SWMU 2.....	15
5	Wildlife Observed at SWMU 2	16
6	Vegetation Observed at SWMU 45.....	21
7	Wildlife Observed at SWMU 45	22

INTRODUCTION

As part of a Resource Conservation and Recovery Act (RCRA) facility investigation at Naval Station (NAVSTA) Roosevelt Roads, Puerto Rico, ecological risk assessments were conducted at 3 solid waste management unit (SWMU) sites. A habitat characterization was conducted at each SWMU in order to determine the presence of plant and animal species and to determine whether preferred habitat was present for any federally endangered or threatened plant and animal species.

SITE LOCATION

NAVSTA Roosevelt Roads (approximately 8,627 acres) is located in the municipality of Ceiba on the southeastern coast of Puerto Rico (Figure 1). This report covers three SWMU sites located at NAVSTA Roosevelt Roads (Figure 2). SWMU 1 and SWMU 2 were located near each other and both had been used as disposal sites and contained similar debris. SWMU 1, an abandoned Army Cremation Disposal Site, is located east of the Navy Lodge with Kearsage Road to the north. Ensenada Honda is to the east and south of SWMU 1, and the Bowling Alley is to the west. SWMU 2 (Langley Drive Disposal Site) is located along Langley Drive and is approximately 2,000 feet northwest of the Navy Exchange. SWMU 2 extends from Langley Drive towards a mangrove community and has an estimated length of 1,300 feet in a northeast-southeast direction. SWMU 45 includes areas outside of Building 38, ground above the cooling water tunnels, and a cove in Puerca Bay. Building 38 is located along a dirt access road south of Forrestal Drive. Associated with Building 38 is a cooling tower intake tunnel that runs from the north end of the building to a small cove in Puerca Bay.

METHODS

Vegetation communities were initially characterized into broad community types based on the color signatures from 1998 true-color and 1993 color infrared (CIR) aerial photographs. Vegetation communities were delineated based on species composition and structure by viewing magnified stereo pairs of aerial photography. The community types were marked on overlying acetate for use in the field (May 15 to 19, 2000). Personnel walked transects through each of these SWMU to:

1. verify that the community types were identified and delineated correctly from the true color and CIR aerial photography;
2. identify the species composition of the dominant vegetation;
3. identify the wildlife species present in the SWMU sites;
4. identify habitat that may potentially support federally designated threatened and endangered species within and contiguous to each SWMU; and
5. identify any obvious impacts potentially related to previous waste management activities.



Figure 1. General Location of NAVSTA Roosevelt Roads, Puerto Rico.

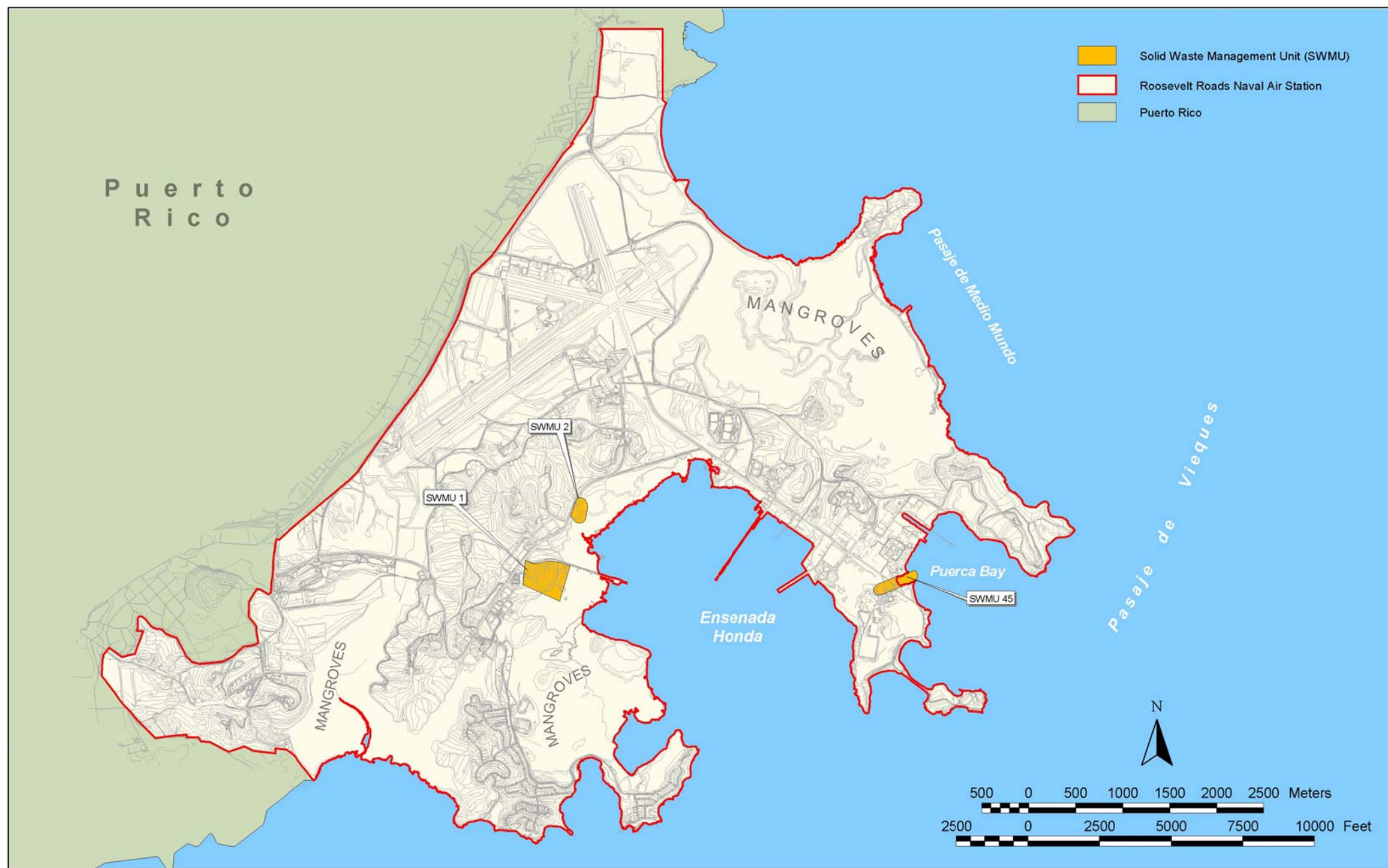


Figure 2. Location of SWMU 1,2 and 45, Roosevelt Roads, Puerto Rico.

The vegetation communities were verified by walking surveys through each community type previously identified with aerial photography. Most species were identified in the field; however, some specimens were collected for identification using reference books (Liogier 1985, 1988, 1994, 1995, 1997; Little and Wadsworth 1964; Little et al. 1964; and Acevedo-Rodriguez 1996) and herbarium specimens. Relative dominance and species structure were characterized from the visual observations within each community type and SWMU.

Wildlife species residing within or utilizing each SWMU habitat, and wildlife habitat were identified during the vegetation field surveys. A wildlife biologist characterized the habitats and determined the types of wildlife that could potentially inhabit the plant communities or SWMU sites. Any wildlife species that were observed were identified in the field with the use of 8 x 40 binoculars and reference guides (Raffaele 1989 and Raffaele et al 1998).

Eleven federally listed species are known to occur or have the potential to occur on NAVSTA Roosevelt Roads (Table 1). The entire NAVSTA Roosevelt Roads was designated as critical habitat in 1976 for the endangered yellow-shouldered blackbird (*Agelaius xanthomus*). However, a 1980 agreement with the USFWS exempted certain areas on the station from this categorization. SWMU 45 is outside this area, while SWMUs 1 and 2 are included within the critical habitat designation.

Prior to conducting the fieldwork, a literature search was conducted for each federally protected species. During the May 15 to 19, 2000 surveys, biologists walked transects through each site and identified any federally protected species seen and noted the presence or absence of preferred habitat for the species.

Table 1

Federally Listed Species Occurring or Potentially Occurring at NAVSTA Roosevelt Roads	
Scientific Name (Common Name)	Federal Status
Plants	
<i>Stahlia monosperma</i> (Cobana negra)	Threatened
Reptiles and Amphibians	
<i>Caretta caretta</i> (Loggerhead sea turtle)	Threatened
<i>Chelonia mydas</i> (Green sea turtle)	Threatened
<i>Dermochelys coriacea</i> (Leatherback sea turtle)	Endangered
<i>Eretmochelys imbricata</i> (Hawksbill sea turtle)	Endangered
<i>Epicrates inornatus</i> (Puerto Rican Boa)	Endangered
Birds	
<i>Agelaius xanthomus</i> (Yellow-shouldered blackbird)	Endangered
<i>Falco peregrinus tundrius</i> (Arctic peregrine)	Threatened
<i>Pelecanus occidentalis occidentalis</i> (Brown pelican)	Endangered
<i>Sterna dougalli dougalli</i> (Roseate tern)	Endangered
Mammals	
<i>Trichechus manatus</i> (West Indian manatee)	Endangered

Source: U.S. Navy 1998b

Past management activities at the SWMU sites may have potentially impacted the current vegetation communities. During the field surveys the biologists made visual observations to characterize the health of the plants in the SWMU sites. Indications of altered plant communities include; chlorotic leaves, epinasty (deformities of leaves and stems), patches of altered plant growth, absence of plants (bare ground), and changes in species composition. To determine if the SWMU sites contained altered plant communities, a nearby representative site was selected as a control. When altered plant communities were identified, the biologists made an effort to determine and record the probable cause (i.e., chemical, soil compaction, natural causes, etc.).

In addition to identification of wildlife in the field, existing literature sources were used to identify any additional species that may have occurred on the SWMU sites but were not observed. Most of the wildlife occurring in the area is bird species and these are presented in Appendix A. Species information and field data was used to generate a simplified food web for the sites. A food web is an interlocking pattern of several to many food chains that is helpful in determining ecosystem processes including those that may occur when a contaminant is introduced to a system.

A reconnaissance survey of SWMU 45 was conducted June 19, 2000 by Dial Cordy and Associates, Inc. to define the marine habitat and associated flora and fauna of the outfall structure and surrounding embayment and shore. Results are presented in the SWMU 45 section.

RESULTS AND DISCUSSION

SWMU 1

Vegetation Community Description

SWMU 1 (an abandoned Army Cremation Disposal Site) is located east of the Navy Lodge (Figure 3). There were four plant communities identified at this site. Geology and human disturbances, to a lesser extent, have influenced the types of plants occurring at this site. The communities included red mangrove (*Rhizophora mangle*), black mangrove, (*Avicennia germinans*), coastal upland forest, and coastal scrub forest. These communities were identified in the NAVSTA Roosevelt Roads Integrated Natural Resources Management Plan (U.S. Navy 1998b) and brief descriptions follow.

The mangrove communities were located farthest east of the Navy lodge in SWMU 1 and had little evidence of human disturbance. Both red and black mangrove communities had sparse cover consisting of low growing shrubs. The red mangroves occurred adjacent to Ensenada Honda and the community was sparsely vegetated (approximately 25 percent cover) with large pools of water present. Nearly all vegetation included short shrubs of red mangrove and numerous red mangrove seedlings were observed.

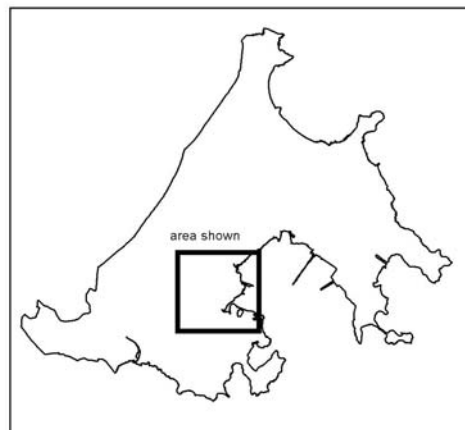
The black mangroves were located inland between the red mangroves and the coastal upland forest community. Species composition consisted of saline tolerant plants as the result of periodic saturation with highly saline water. The site had sparse vegetation cover (approximately 25 percent) and plants were predominately short shrubs (8 to 15 feet). In addition, there was some herbaceous vegetation near the inland boundary. Black mangrove trees and shrubs dominated the shrub vegetation. The herbaceous vegetation was dominated by *Batis maritima*, with *Sporobolus virginicus* and *Sesuvium portulacastrum* also present.

An upland coastal forest community was located on the southern portion of the hill to the east of the Navy lodge. The upland coastal forest served as the upland boundary of the black mangrove community. Soil disturbance, debris, and an un-maintained road for access to several monitoring wells were observed. Tree cutting may have occurred in this area in the past; however, relatively large trees were observed. Shrubs with scattered large trees (8 to 14 inches in diameter breast height) and grassy areas dominated the community. There was approximately 80 to 90 percent vegetation cover with multiple layers of stratification. *Leucaena leucocephala*, *Bursera simaruba*, and *Randia aculeata* dominated the shrub layer. *Bucida buceras*, *Trichostigma octandrum*, and *Psidium guajava* were the only trees present, and these were confined to the ridges and steep hillsides. Patches of herbaceous areas were dominated by *Panicum maximum*.

The coastal scrub forest community also showed signs of soil disturbance and had vegetation similar to the upland forest community. However, the coastal scrub had less topographic relief, fewer trees, and larger grassy patches than the upland forest. Vegetation cover in the coastal scrub was approximately 80 to 95 percent and was limited to two stratus (shrub and herbaceous). The lack of tree cover had probably occurred due to slope exposure to hurricane force winds. *Leucaena leucocephala* and *Panicum maximum* dominated the shrub and herbaceous stratus, respectively. Vegetation photos for SWMU 1 are presented in Figures 4 and 5. The vegetation observed at SWMU 1 is presented in Table 2.

Plant Community Health

The control for SWMU 1 was carefully chosen in order to represent the different plant communities present. Factors needed for the control included a protected hillside community adjacent to mangroves and proximity to SWMU 1. The control that was chosen had upland coastal forest, coastal scrub forest, and mangroves similar to SWMU 1 and was located on the south side of Langley Drive between the elementary school and South Princeton Road.



U.S. Naval Station Roosevelt Roads, Puerto Rico

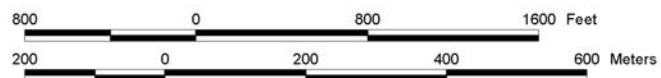


Figure 3. Location of SWMU 1, Roosevelt Roads, Puerto Rico



Figure 4. SWMU 1, Red Mangrove Community (*Rhizophora mangle*) with Upland Coastal Forest in Background.



Figure 5. SWMU 1, Coastal Scrub Forest Community

Table 2
Vegetation Observed at SWMU 1

Common Name	Scientific Name	Stratum
Black Mangrove		
black mangrove	<i>Avicenia germinans</i>	S
salt plant, saltwort	<i>Batis maritima</i>	H
white mangrove	<i>Laguncularia racemosa</i>	S
verdolaga rosada, pink purslane	<i>Sesuvium portulacastrum</i>	H
None	<i>Sporobolus virginicus</i>	H
Red Mangrove		
red mangrove	<i>Rhizophora mangle</i>	S
Upland Coastal Forest		
crab's eye, jumbie bead, rosary bead	<i>Abrus precatorius</i>	S
none	<i>Acacia westiana</i>	S
none	<i>Bothriochloa ichaemum</i>	H
Ucar, oxhorn bucida	<i>Bucida buceras</i>	T
almácigo	<i>Bursera simaruba</i>	S/T
bottle wiss	<i>Capparis flexusa</i>	S
French grass	<i>Commelina erect</i>	H
Bermuda grass	<i>Cynodon dactylon</i>	H
none	<i>Ipomea</i> spp.	V
none	<i>Lasiacis divaricata</i>	H
none	<i>Leptochloa ichaemum</i>	H
tan tan, tanty, wild tamarind, lead tree	<i>Leucaena leucocephala</i>	S
none	<i>Panicum maximum</i>	H
guayaba, common guayaba	<i>Psidium guajava</i>	T
Christmas tree, tintillo	<i>Randia aculeata</i>	S
none	<i>Sporobolus indicus</i>	H
none	<i>Tragia volubilis</i>	H
basket wiss	<i>Trichostigma octandrum</i>	S/T
marsh-mallow	<i>Waltheria indica</i>	H
Coastal scrub forest		
none	<i>Asystasia gangetica</i>	H
almácigo	<i>Bursera simaruba</i>	S
bottle wiss	<i>Capparis flexusa</i>	S
none	<i>Cissus obovata</i>	V
palma de coco	<i>Cocos nucifera</i>	S
rattle box, yellow lupine	<i>Crotalaria retusa</i>	H
flamboyant tree, Poinciana	<i>Delonix regia</i>	S
brazilette	<i>Erythroxylum brevipes</i>	S
none	<i>Forestiera eggersiana</i>	S
black mampoo, wild mampoo	<i>Guapira fragans</i>	S
none	<i>Ipomea</i> spp.	H
tan tan, tanty, wild tamarind, lead tree	<i>Leucaena leucocephala</i>	S
cat claw, cat paw, monkey earing	<i>Macfadyena unguis-cati</i>	S
none	<i>Panicum maximum</i>	H
none	<i>Pinzona coriacea</i>	H
Christmas tree, tintillo	<i>Randia aculeata</i>	S
royal palm	<i>Roystonea borinquena</i>	S
basket wiss, white root, black or white wist	<i>Serjania polyphylla</i>	V
basket wiss	<i>Trichostigma octandrum</i>	S/T

S = shrub
T = tree
H = herbaceous
V = vine

There were no noticeable differences in plant community species composition between the control and the SWMU 1 site. However, the structure of the plant communities was somewhat different. SWMU 1 had more grassy areas within the coastal scrub forest community than the control. The increase in grassy areas was probably the result of past dirt-moving activities at SWMU 1. There were also more large trees at SWMU 1 in the upland coastal forest community than the control. It appeared that the control hillside had been more exposed to hurricane force winds thus resulting in fewer large trees.

The SWMU 1 plant communities seemed to be growing healthy and vigorously. The mangrove communities had a low vegetation cover; however, depending upon their position in the landscape, this is not uncommon. Debris and evidence of dirt-moving activities were observed in the upland coastal forest and the coastal scrub forest communities, but ecological succession was occurring and the existing forest communities had no evidence of stress.

Wildlife Description

During the short duration of wildlife surveys conducted on this site, numerous wildlife species such as birds and lizards (*Anolis* species) were observed utilizing the habitat of this site. An active Wilson's plover (*Charadrius wilsonia*) nest was found in the black mangrove community. The mangrove communities also had significant crab activity. The red mangrove community, with more water present, had more crab holes than the black mangroves. There was no evidence that the SWMU site had an impact on the wildlife diversity or its habitat. Wildlife that was observed at SWMU 1 is presented in Table 3.

Protected Species

Stahlia monosperma (Cobana negra), a federally threatened tree, has been found between the boundary of black mangrove communities and coastal upland forest communities. This species is also known to occur in coastal forests of southeastern Puerto Rico (Little and Wadsworth 1964). However, this species has not been verified as occurring on NAVSTA Roosevelt Roads by past surveys (U.S. Navy 1998b) and was not observed during the surveys.

The Puerto Rican boa (*Epicrates inornatus*) utilizes a variety of habitats but is most commonly found in karst forest habitats. The coastal upland forest community habitat at SWMU 1 is similar to karst habitat due to the steep topography and presence of large stature trees (an indicator of minimal recent disturbance). Occurrence of the boa at NAVSTA Roosevelt Roads has not been verified and due to the disturbance at SWMU 1, there is a low probability of occurrence for the species at this site.

Table 3
Wildlife Observed at SWMU 1

English Name	Scientific Name	Local Name
Red and Black Mangrove Communities		
Birds		
Green Mango	<i>Anthracothorax viridis</i>	Zumbador Verde de P.R.
Red-tailed Hawk	<i>Buteo jamaicensis</i>	Guaraguo de Cola Roja
Wilson's Plover	<i>Charadrius wilsonia</i>	Playero Marítimo
Yellow Warbler	<i>Dendroica petechia</i>	Canario de Mangle
Common Moorhen	<i>Gallinula chloropus</i>	Gallareta Común
Ruddy Quail-Dove	<i>Geotrygon montana</i>	Perdiz Pequeña
Puerto Rico Woodpecker	<i>Melanerpes portoricensis</i>	Carpintero de Puerto Rico
Northern Mockingbird	<i>Mimus polyglottos</i>	Ruiseñor
Cave Swallow	<i>Pterochelidon fulva</i>	Golondrina de Cuevas
Greater Antillean Grackle	<i>Quiscalus niger</i>	Mozambique (Chango)
Louisiana Waterthrush	<i>Seiurus motacilla</i>	Pizpita de Rio
Loggerhead Kingbird	<i>Tyrannus caudifasciatus</i>	Clérigo
Gray Kingbird	<i>Tyrannus dominicensis</i>	Pitirre
Upland Coastal Forest		
Reptiles and Amphibians		
Crested Anole	<i>Anolis cristatellus</i>	not known
Birds		
Red-tailed Hawk	<i>Buteo jamaicensis</i>	Guaraguo de Cola Roja
Bananaquit	<i>Coereba flaveola</i>	Reinita Común
Yellow Warbler	<i>Dendroica petechia</i>	Canario de Mangle
Ruddy Quail-Dove	<i>Geotrygon montana</i>	Perdiz Pequeña
Pearly-eyed Thrasher	<i>Margarops fuscatus</i>	Zorzal Pardo
Northern Mockingbird	<i>Mimus polyglottos</i>	Ruiseñor
Greater Antillean Grackle	<i>Quiscalus niger</i>	Mozambique (Chango)
Coastal Scrub Forest		
Reptiles and Amphibians		
Brown Lizard	<i>Anolis cristatellus</i>	not known
Lizard	<i>Anolis stratulus</i>	not known
Birds		
Bananaquit	<i>Coereba flaveola</i>	Reinita Común
Ruddy Quail-Dove	<i>Geotrygon montana</i>	Perdiz Pequeña
Grackle	<i>Quiscalus niger</i>	Mozambique (Chango)
Loggerhead Kingbird	<i>Tyrannus caudifasciatus</i>	Clérigo
Gray Kingbird	<i>Tyrannus dominicensis</i>	Pitirre
Black-Whiskered Vireo	<i>Vireo altiloquus</i>	Bien-te-veo
Zenaida Dove	<i>Zenaida aurita</i>	Tórtola cardosantera

Federally threatened and endangered sea turtles such as the Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Loggerhead (*Caretta caretta*) and Leatherback sea turtles (*Dermochelys coriacea*) and the endangered West Indian Manatee (*Trichechus manatus*) would not occur at this site because they require marine habitats. There is potential for some of the species to occur in nearby Ensenada Honda, however most of the site considered here contained terrestrial habitat.

Federally endangered marine birds such as the Brown pelican (*Pelecanus occidentalis occidentalis*) and the Roseate tern (*Sterna dougalli dougalli*) would most likely not occur at this terrestrial site due to the absence of preferred habitat. The Roseate tern has not been observed on or adjacent to the NAVSTA Roosevelt Roads (U.S. Navy 1998b), although it has been observed recently at Vieques Island. Brown pelicans prefer more coastal areas.

Potential upland feeding habitat (shrubland) was present for the yellow-shouldered blackbird (*Agelaius xanthomus*). However, nesting habitat for the species (mature mangroves and Royal Palm [*Roystonea borinquena*]) was not present. Some nesting habitat may have been located adjacent to the site (U.S. Navy 1998a). A pair of yellow-shouldered blackbirds was observed near the site, although only seven sightings in all have been reported at NAVSTA Roosevelt Roads from 1986 to 1996.

The Arctic peregrine falcon (*Falco peregrinus tundrius*) has been observed at NAVSTA Roosevelt Roads (U.S. Navy 1998b). This species utilizes open grassland areas for potential feeding areas. This type of habitat was not present at or near this site.

Food Web

The information in a food web is very important when considering the potential for contaminants existing in the ecosystem. Many contaminants are passed from one trophic level to the next. A contaminant at the soil surface goes through a different process than a contaminant that has leached into the soil. The surface contaminant may be ingested by a decomposer such as a hermit crab and then passed on to the secondary consumer (i.e., a carnivorous bird). Leached contaminants are picked up by the primary producers and are then passed upwards in the food chain.

Figure 6 presents a generalized food web for the upland coastal forest and the coastal scrub forest communities. Figure 7 presents a food web for the mangrove communities. The abundance within each of the food groups is represented by the size of their polygon in the figure. Dominant species are listed in each of the food groups except for plants, which were provided previously in this section.

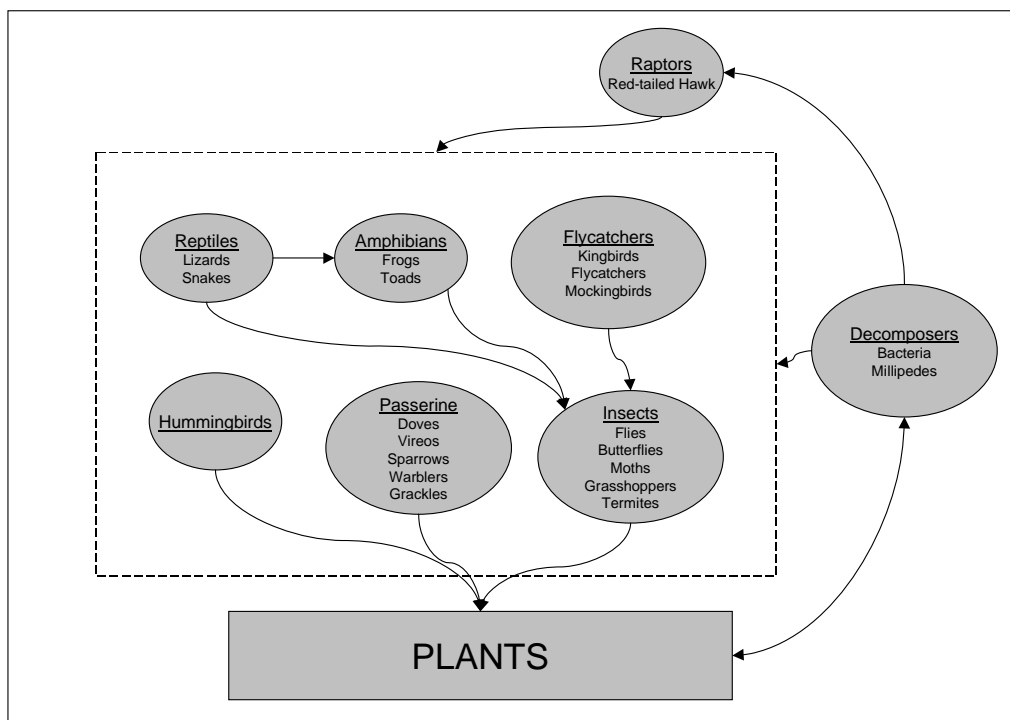


Figure 6. Generalized Food Web for the Upland Coastal Forest and Coastal Scrub Forest Communities at NAVSTA Roosevelt Roads.

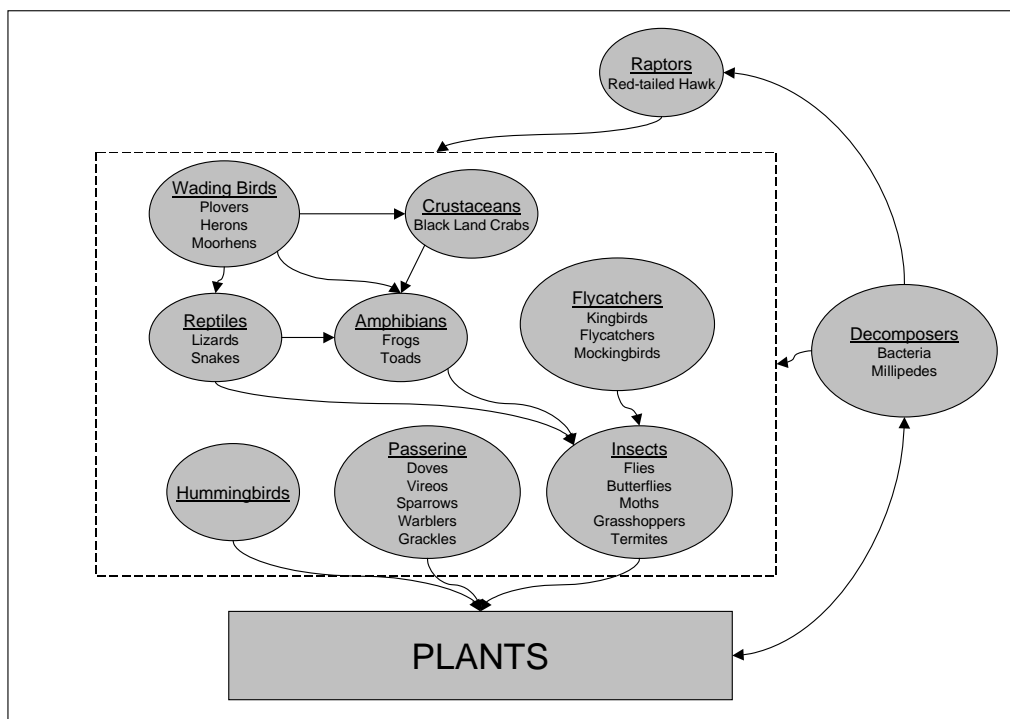


Figure 7. Generalized Food Web for Mangrove Communities at NAVSTA Roosevelt Roads.

SWMU 2

Vegetation Community Description

SWMU 2, Langley Drive Disposal Site, is located along Langley Drive and is approximately 2,000 feet northwest of the Navy Exchange. SWMU 2 extends from Langley Drive in a gentle slope towards a mangrove community and has an estimated length of 1,300 feet in a northeast-southeast direction. Disturbances consisted of an un-maintained road that led to a monitoring well. There was a small earthen berm running parallel to the mangrove boundary. The dominant vegetation was upland coastal forest; however, the adjacent black mangrove community was also described.

Various stages of ecological succession were observed throughout the upland coastal forest community and canopy cover approached 100 percent. The dominant plant community along the monitoring well road was herbaceous vegetation with *Leucaena leucocephala* shrubs, *Panicum maximum*, *Sporobolus indicus*, and *Waltheria indica*. Road edges were a nearly monotypic stand of *Leucaena leucocephala* shrubs. Further from the monitoring well road, there were fewer individuals of *Leucaena leucocephala* and more upland coastal forest plant community species such as *Bursera simaruba*, *Erthroxylum brevipes*, and *Capparis flexusa*.

Although the mangrove community was limited within SWMU 2, it is described here and included in Table 4. The mangrove community formed the boundary for SWMU 2 and contained a number of additional species that are not typically found in mangrove communities. Because the area described was in the upland/wetland boundary (ecotone) of the community and there was adjacent road disturbance, higher species richness would be expected. Dominant plants included black mangrove, *Leucaena leucocephala*, and *Randia aculeata*. Vegetation photos are presented in Figures 9 and 10. The vegetation observed at SWMU 2 is presented in Table 4.

Plant Community Health

The control for SWMU was a similar plant community found on the eastern boundary of SWMU 2 along Langley Road. The control had similar topography, soils, position in landscape, and it was located between a paved road and a mangrove community. The only difference between the control and SWMU 2 was that SWMU 2 contained a road that had created an opening in the plant community. This opening had allowed an herbaceous stratum to establish and *Leucaena leucocephala* dominated the road edges. No other vegetation stresses were observed throughout the SWMU 2 community when compared to the control.

Table 4
Vegetation Observed at SWMU 2

Common Name	Scientific Name	Stratum
Upland Coastal Forest		
aroma, sweet acacia	<i>Acacia farnesiana</i>	S
none	<i>Bothriochloa ichaemum</i>	H
bottle wiss	<i>Capparis flexusa</i>	S
none	<i>Cissus obovata</i>	V
none	<i>Ipomea spp.</i>	V
tan tan, tanty, wild tamarind, zarcilla	<i>Leucaena leucocephala</i>	S
none	<i>Macfadyena unguis-cati</i>	S
none	<i>Panicum maximum</i>	H
cattle tongue, sweet scent	<i>Pluchea carolinensis</i>	H
none	<i>Sporobolus indicus</i>	H
yerba socialista, socialist herb	<i>Vernonia cinerea</i>	H
marsh mallow	<i>Waltheria indica</i>	H
Black mangrove		
black mangrove	<i>Avicenia germinans</i>	S/T
almácigo, turpentine-tree	<i>Bursera simaruba</i>	S/T
bottle wiss	<i>Capparis flexuosa</i>	S
Black willie, Jamaican caper	<i>Capparis cynophallophora</i>	S/T
brazilette	<i>Erythroxylum brevipes</i>	S
none	<i>Foresteria eggersiana</i>	S
black mampoo, wild mampoo	<i>Guapira fragans</i>	S
none	<i>Lasiacis divaricata</i>	H
tan tan, tanty, wild tamarind, lead tree	<i>Leucaena leucocephala</i>	S
none	<i>Panicum maximum</i>	H
Christmas tree, tintillo	<i>Randia aculeata</i>	S
none	<i>Sporobolus indicus</i>	H
S = shrub		
T = tree		
H = herbaceous		
V = vine		

Wildlife Description

During the short duration of wildlife surveys conducted on this site, numerous wildlife species including birds, lizards, frogs, and crabs were observed utilizing the habitat of this site (Table 5). A large land crab (*Ucar* species) was observed in the mangrove community. There was no evidence that the SWMU site had an impact on the wildlife or its habitat.

Protected Species

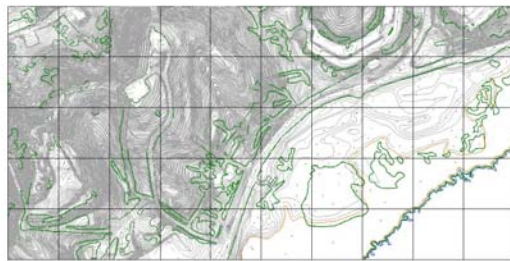
SWMU 2 was in close proximity and had similar habitat as SWMU 1. There were no federally protected species or preferred habitat observed at SWMU 2. See the discussion on protected species for SWMU 1 for information on potentially occurring species and their habitat.

Food Web

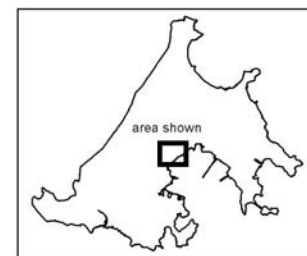
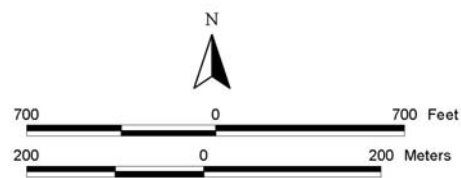
Figures 6 and 7 present generalized food webs for the upland coastal forest and mangrove communities, respectively.

Table 5
Wildlife Observed at SWMU 2

English Name	Scientific Name	Local Name
Upland Coastal Forest		
Reptiles and Amphibians		
Lizard	<i>Anolis cristatellus</i>	not known
Lizard	<i>Anolis pulchellus</i>	not known
Frog	<i>Eleutherodactylus sp.</i>	not known
Frog	<i>Leptodactylus albilabris</i>	not known
Birds		
Red-tailed Hawk	<i>Buteo jamaicensis</i>	Guaraguao de Cola Roja
Yellow Warbler	<i>Dendroica petechia</i>	Canario de Mangle
Pearly-eyed Thrasher	<i>Margarops fuscatus</i>	Zorzal Pardo
Puerto Rico Woodpecker	<i>Melanerpes portoricensis</i>	Carpintero de Puerto Rico
Northern Mockingbird	<i>Mimus polyglottos</i>	Ruiseñor
Greater Antillean Grackle	<i>Quiscalus niger</i>	Mozambique (Chango)
Gray Kingbird	<i>Tyrannus dominicensis</i>	Pitirre
Black-Whiskered Vireo	<i>Vireo altiloquus</i>	Bien-te-veo
Zenaida Dove	<i>Zenaida aurita</i>	Tórtola Cardosanterá
Mangrove		
Crustacean		
Land Crab	<i>Ucar sp.</i>	Ucar
Birds		
Bananaquit	<i>Coereba flaveola</i>	Reinita Común
Loggerhead Kingbird	<i>Tyrannus caudifasciatus</i>	Clérigo
Black-Whiskered Vireo	<i>Vireo altiloquus</i>	Bien-te-veo
Zenaida Dove	<i>Zenaida aurita</i>	Tórtola Cardosanterá



Topography



U.S. Naval Station Roosevelt Roads, Puerto Rico

Figure 8. Location of SWMU 2, Roosevelt Roads, Puerto Rico



Figure 9. SWMU 2, Un-maintained Road in Center of Photograph within the Upland Coastal Forest Community.



Figure 10. SWMU 2, Typical Vegetation Showing Upland Coastal Forest Species

SWMU 45

Terrestrial Area

Vegetation Community Description

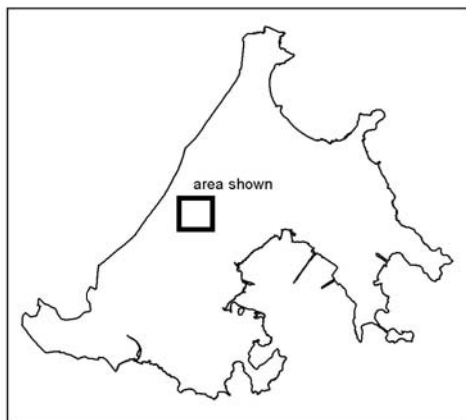
SWMU 45 included areas outside of Building 38, the right-of-way for the cooling water tunnels, and a small cove in Puerca Bay (Figure 11). Building 38 is located along a dirt access road south of Forrestal Drive. Grounds maintenance and building maintenance activity appeared to have been abandoned a few years ago. NAVSTA Roosevelt Roads INRMP indicated that the general cover type for the terrestrial portion of SWMU is urban/developed (U.S. Navy, 1998b). However, observations of the present species composition indicated that the site was in the early ecological succession stages of an upland coastal forest community. In addition to the vegetation around the building and the cooling water tunnel right-of-way, there was a fringe of mangroves along the cove of Puerca Bay. The marine environment at the small cove within Puerca Bay is discussed later.

The majority of the site was located on nearly level upland terrain with almost 100 percent vegetation cover. Shrubs dominated the site, except where road corridors occurred. Maintained grasses such as *Bothriochloa ischaemum*, *Chloris barbata*, and *Digitaria* sp. dominated the road corridors while 10 to 15-foot tall *Leucaena leucocephala* shrubs dominated the un-maintained areas.

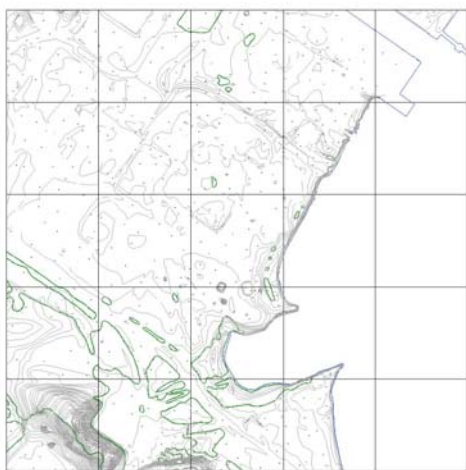
The small cove at Puerca Bay was shallow and had been excavated for the water cooling tunnels. The fringe of the bay had near 100 percent shrub cover and little to no herbaceous vegetation. *Thespesia populnea* shrubs dominated the community. There were also sparse black mangroves, *Stachytarpetta jamaicensis*, and *Heliotropium curassavicum* present. A wildlife photo along the cove shoreline is presented in Figure 12. The vegetation observed at SWMU 45 is presented in Table 6.

Plant Community Health

Because SWMU 45 was very similar to SWMU 2 in species composition, community structure, and topography, the same control plot was used for both sites. The control was located along Langley Road adjacent to the eastern boundary of SWMU 2. There were minimal differences between the control and SWMU 45. Most of SWMU 45 had been well maintained, but it appeared that recent lack of maintenance had allowed *Leucaena leucocephala*, an invasive species, to increase. Besides mowing and other grounds maintenance practices at SWMU 45, there were no other plant community stresses observed.



U.S. Naval Station Roosevelt Roads, Puerto Rico



Topography

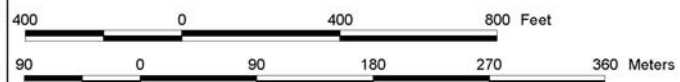


Figure 11. Location of SWMU 45, Roosevelt Roads, Puerto Rico



Figure 12. SWMU 45, Along the Shoreline of the Cove, Killdeer (*Charadrius vociferous*) Foraging Among Washed-up Seagrass.

Table 6
Vegetation Observed at SWMU 45

Common Name	Scientific Name	Stratum
Upland Coastal Forest		
bay flower	<i>Blutaparon vermiculare</i>	H
almácigo, turpentine-tree	<i>Bursera simaruba</i>	S/T
Barbados pride, dwarf poinciana	<i>Caesalpinia pulcherrima</i>	S
bottle wiss	<i>Capparis flexusa</i>	S
conchita de Virginia	<i>Centrosema virginianum</i>	V
none	<i>Chloris barbata</i>	H
péndula de sierra, fiddlewood	<i>Citharexylum caudatum</i>	S/T
copper	<i>Cordia alliodora</i>	S
none	<i>Dalbergia ecastaphyllum</i>	S
cotton	<i>Gossypium barbadense</i>	H
bay vine	<i>Ipomea pes-caprae</i>	V
willy vine	<i>Ipomea tiliacea</i>	V
tan tan, tanty, wild tamarind	<i>Leucaena leucocephala</i>	S
batatilla blanca	<i>Merremia quinquefolia</i>	V
Bellyache balsam, bitter bushplant	<i>Oncimum campechianum</i>	S
Prickly mampoo	<i>Pisonia aculeata</i>	S
guamá americano, guamuchil	<i>Pithcellobium dulce</i>	S
Christmas tree, tintillo	<i>Randia aculeata</i>	S
royal palm	<i>Roystonea borinquena</i>	S
bay flower, sea purslane, sea pusley	<i>Sesuvium portulacastrum</i>	H
None	<i>Sida rhombifolia</i>	S
Mangrove		
sea pusley	<i>Heliotropium curassavicum</i>	H
black mangrove	<i>Laguncularia racemosa</i>	S/T
None	<i>Stachytarpetta jamaicensis</i>	H/S
seaside mahoe, emajaguilla, portiatree	<i>Thespesia populnea</i>	S
S = shrub T = tree		
H = herbaceous V = vine		

Wildlife Description

During the short duration of wildlife surveys conducted on this site, numerous wildlife species such as birds and lizards were observed utilizing the habitat of this site (Table 7). Bird species were typical of coastal forest and shore species due to the proximity of the site to the open waters of Puerca Bay. There was no evidence that the SWMU site had an impact on the wildlife or habitat.

Protected Species

There were no federally protected species or preferred habitat observed at this site. The federally threatened plant *Stahlia monosperma* and the endangered Puerto Rican boa (*Epicrates inornatus*) would not be expected to inhabit the area since the site has been disturbed. Intact coastal forest habitat is not present (preferred habitat for the Puerto Rican boa) and only sparse black mangroves were present along the fringe of the Puerca Bay cove, so *Stahlia monosperma* would probably not occur. SWMU 45 is outside the area of critical habitat designation, although potential feeding habitat (shrubland) for the Yellow-shouldered blackbird was present at the site.

Table 7
Wildlife Observed at SWMU 45

English Name	Scientific Name	Local Name
Reptiles and Amphibians		
Lizard	<i>Anolis cristatellus</i>	Not known
Birds		
Killdeer	<i>Charadrius vociferous</i>	Playero Sabanero
Common-ground Dove	<i>Columbina passerina</i>	Rolita
Yellow Warbler	<i>Dendroica petechia</i>	Canario de Mangle
Magnificent Frigatebird	<i>Fregata magnificens</i>	Tijerilla (Rabijunco)
Pearly-eyed Thrasher	<i>Margarops fuscatus</i>	Zorzal Pardo
Northern Mockingbird	<i>Mimus polyglottos</i>	Ruiseñor
Cave Swallow	<i>Pterochelidon fulva</i>	Golondrina de Cuevas
Greater Antillean Grackle	<i>Quiscalus niger</i>	Mozambique (Chango)
Gray Kingbird	<i>Tyrannus dominicensis</i>	Pitirre
White-winged Dove	<i>Zenaida asiatica</i>	Tórtola Aliblanca
Zenaida Dove	<i>Zenaida aurita</i>	Tórtola Cardosanterá

Food Web

A generalized food web for the upland coastal forest community is provided in Figure 6.

Marine Area

A reconnaissance survey of SWMU 45 was conducted June 19, 2000 (Dial Cordy and Associates Inc., 2000) to define the marine habitat and associated flora and fauna of the outfall structure and surrounding embayment and shore. Marine habitats observed in the study area included: rocky rubble subtidal zone,

shallow subtidal sandy shelf, shelf slope, deep level bottom of embayment, and the outfall structure. A complete list of the marine flora and fauna observed at SWMU 45 is given in the Dial Cordy report (Dial Cordy and Associates Inc., 2000), which is included in Appendix B.

The rocky subtidal zone was located along the shoreline of the embayment and served as a means of shore protection. The rocky habitat was occupied by marine algal species (*Halimeda tuna*, *H. opuntia*, *Penicillus pyriformis*, and *Udotea* species), invertebrates such as sea urchins (*Echinometra lucunter* and *E. viridis*), encrusting fire coral (*Millipora alcornus*), common sea fan (*Gorgonia ventalina*), and starlet coral (*Siderastrea radians*). Sixteen fish species were seen and common species included sergeant major (*Abudefduf saxatilis*), dusky damselfish (*Stegastes fuscus*), tomtate (*Haemulon aurolineatum*), gray snapper (*Lutjanus griseus*), and squirrelfish (*Holocentrus* species). Most of the fish species were using the rocky zone for food and refuge from predators.

The shallow subtidal sandy shelf was characterized as a seagrass/algal bed dominated by turtle grass (*Thalassia testudinum*). Seagrass cover ranged from approximately 50 to 75 percent. Marine invertebrates included pincushion starfish (*Oreaster reticulatus*), several species of sea cucumbers, and the corkscrew anemone (*Bartholomea annulatta*). Common fish included the tomtate and gray snappers.

The shelf slope was devoid of seagrass and was characterized by marine algae. Fish observed included the yellowfin mojarra (*Gerres cinereus*) and silver jenny (*Eucinostomus gula*). The level sand bottom around the mouth of the outfall structure was un-vegetated and due to low visibility and depth, no large invertebrates or fish were observed.

The outfall structure itself supported a hardbottom community dominated by soft corals (*Leptogorgia* species, *Muricea elongata*, *Gorgonia ventalina*), marine algae (*Caulerpa racemosa* and *Cladophora* species), sponges (*Cliona* species), and fire coral.

CONCLUSION

The past activities at all to the SWMU sites presented in this report have some degree of impacts on their ecosystems. However, these impacts appear to be limited to changes in species composition based on physical disturbances. The construction of roads, rounds maintenance, and the addition of an outfall structure to the cove at Puerca Bay were only disturbances that have caused noticeable differences. Wildlife at these sites seems to be healthy and utilizing the habitats to their fullest extent. Through these surveys, no federally protected species were identified at these sites.

LITERATURE CITED

- Acevedo-Rodriguez, P. 1996. Flora of St. John; U.S. Virgin Islands. The New York Botanical Garden. Bronx, NY.
- Dial Cordy and Associates, Inc. 2000. Marine Resource Survey of SWMU Site NAS Roosevelt Roads, Puerto Rico. Prepared by Dial Cordy and Associates, Inc. for Geo-Marine, Inc., Fajardo, Puerto Rico.
- Liogier, H.A. 1985. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta Vol. 1 Casuarinaceae to Connaraceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.
- Liogier, H.A. 1988. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta. Vol. 2. Leguminosae to Anacardiaceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.
- Liogier, H.A. 1994. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta. Vol. 3. Cyrillaceae to Myrtaceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.
- Liogier, H.A. 1995. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta. Vol. 4. Melastomataceae to Lentibulariaceae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.
- Liogier, H.A. 1997. Descriptive Flora of Puerto Rico and Adjacent Islands; Spermatophyta. Vol. 5. Acanthaceae to Compositae. Editorial de la Universidad de Puerto Rico, Rio Piedras, Puerto Rico.
- Little, E.L., and F.H. Wadsworth. 1964. Common Trees of Puerto Rico and the Virgin Islands. Agriculture Handbook No. 249. U.S. Department of Agriculture, Forest Service, Washington, D.C.
- Little, E.L., R. Woodbury, and F.H. Wadsworth. 1964. Trees of Puerto Rico and the Virgin Islands. Vol. 2. Agriculture Handbook No. 449. U.S. Department of Agriculture, Forest Service, Washington, D.C.
- Raffaele, H. A. 1989. A Guide to the Birds of Puerto Rico and the Virgin Islands. Princeton University Press. Princeton, New Jersey.
- Raffaele, H., J. Wiley, O. Garrido, A. Keith, and J. Raffaele. 1998. A Guide to the Birds of the West Indies. Princeton University Press. Princeton, New Jersey.
- U.S. Navy. 1998a. Draft Pre-Consultation Plan for the Puerto Rican Boa. Prepared by Geo-Marine, Inc. for Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia, and U.S. Naval Security Group Activity, Ceiba, Puerto Rico.
- U.S. Navy. 1998b. Final Integrated Natural Resource Management Plan. Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia, and U.S. Naval Station Roosevelt Roads, Ceiba, Puerto Rico. 15 p.

APPENDIX A

Birds Potentially Occurring at NAVSTA Roosevelt Roads

Pied-billed grebe (*Podilymbus podiceps*)
Red-billed tropicbird (*Phaethon aethereus*)
Brown pelican (*Pelecanus occidentalis*)
Brown booby (*Sula leucogaster*)
Magnificent frigatebird (*Fregata magnificens*)
Great blue heron (*Ardea herodias*)
Louisiana heron (*Hydranassa tricolor*)
Snowy egret (*Egretta thula*)
Great egret (*Egretta alba*)
Striated heron (*Butorides striatus*)
Little blue heron (*Florida caerulea*)
Cattle egret (*Bubulcus ibis*)
Least bittern (*Ixobrychus exilis*)
Yellow-crowned night heron (*Nyctanassa violacea*)
Black-crowned night heron (*Nycticorax nycticorax*)
White-cheeked pintail (*Anas bahamensis*)
Blue-winged teal (*Anas discors*)
American widgeon (*Anas americana*)
Red-tailed hawk (*Buteo jamaicensis*)
Osprey (*Pandion haliaetus*)
Merlin (*Falcon columbarius*)
Clapper rail (*Rallus longirostris*)
American coot (*Fulica americana*)
Caribbean coot (*Fulica caribaea*)
Common gallinule (*Gallinula chloropus*)
Piping plover (*Charadrius melodus*)
Semipalmated plover (*Charadrius semipalmatus*)
Black-bellied plover (*Squatarola squatarola*)
Wilson's plover (*Charadrius wilsonia*)
Killdeer (*Charadrius vocifera*)
Ruddy turnstone (*Arenaria interpres*)
Black-necked stilt (*Himantopus himantopus*)
Whimbrel (*Numenius phaeopus*)
Spotted sandpiper (*Actitis macularia*)
Semipalmated sandpiper (*Calidris pusilla*)
Short-billed dowitcher (*Limnodromus griseus*)
Greater yellowlegs (*Tringa melanoleuca*)
Lesser yellowlegs (*Tringa flavipes*)
Willet (*Catoptrophorus semipalmatus*)
Stilt sandpiper (*Micropalama himantopus*)
Pectoral sandpiper (*Calidris melanotos*)
Laughing gull (*Larus atricilla*)
Royal tern (*Thalasseus maximus*)
Sandwich tern (*Thalasseus sandvicensis*)
Bridled tern (*Sterna anaethetus*)
Least tern (*Sterna albifrons*)
Brown noddy (*Anous stolidus*)
White-winged dove (*Zenaida asiatica*)
Zenaida dove (*Zenaida aurita*)
White-crowned pigeon (*Columba leucocephala*)
Mourning dove (*Zenaida macroura*)
Red-necked pigeon (*Columba squamosa*)
Common ground dove (*Columba passerina*)
Bridled quail dove (*Geotrygon mystacea*)

Birds Potentially Occurring at NAVSTA Roosevelt Roads (Continued)

Ruddy quail dove (*Geotrygon montana*)
Caribbean parakeet (*Aratinga pertinax*)
Smooth-billed ani (*Crotophaga ani*)
Yellow-billed cuckoo (*Coccyzus americanus*)
Mangrove cuckoo (*Coccyzus minor*)
Short-eared owl (*Asio flammeus*)
Chuck-will's-widow (*Caprimulgus carolinensis*)
Common nighthawk (*Chordeiles minor*)
Antillean crested hummingbird (*Orthorhynchus cristatus*)
Green-throated carib (*Sericotes holosericeus*)
Antillean mango (*Anthracothonax dominicus*)
Belted kingfisher (*Ceryle alcyon*)
Gray kingbird (*Tyrannus dominicensis*)
Loggerhead kingbird (*Tyrannus caudifasciatus*)
Stolid flycatcher (*Myiarchus stolidus*)
Caribbean elaenia (*Elaenia martinica*)
Purple martin (*Progne subis*)
Cave swallow (*Petrochelidon fulva*)
Barn swallow (*Hirundo rustica*)
Northern mockingbird (*Mimus polyglottos*)
Pearly-eyed thrasher (*Maragarops fuscatus*)
Red-legged thrush (*Mimocichla plumbea*)
Black-whiskered vireo (*Vireo altiloquus*)
American redstart (*Setaophaga ruticilla*)
Parula warbler (*Parula americana*)
Prairie warbler (*Dendroica discolor*)
Yellow warbler (*Dendroica petechia*)
Magnolia warbler (*Dendroica magnolia*)
Cape May warbler (*Dendroica tigrina*)
Black-throated blue warbler (*Dendroica caerulescens*)
Adelaide's warbler (*Dendroica adelaidae*)
Palm warbler (*Dendroica palmarum*)
Black and white warbler (*Mniotilta varia*)
Ovenbird (*Seiurus aurocapillus*)
Northern water thrush (*Seiurus noveboracensis*)
Bananaquit (*Coerba flaveola*)
Striped-headed tanager (*Spindalis zena*)
Shiny cowbird (*Molothrus bonariensis*)
Black-cowled oriole (*Icterus dominicensis*)
Greater Antillean grackle (*Quiscalis niger*)
Yellow-shouldered blackbird (*Agelaius xanthomus*)
Hooded mannikin (*Lonchura cucullata*)
Yellow-faced grassquit (*Tiaris olivacea*)
Black-faced grassquit (*Tiaris bicolor*)
Least sandpiper (*Calidris minutilla*)
Western sandpiper (*Calidris mauri*)
Puerto Rican woodpecker (*Melanerpes portoricensis*)
Rock dove (*Columba livia*)
Puerto Rican emerald (*Chlorostilbon maugeus*)
Puerto Rican flycatcher (*Myiarchus antillarum*)
Pin-tailed whydah (*Vidua macroura*)
Spice finch (*Lonchura punctulata*)
Ruddy duck (*Oxyura jamaicensis*)
Peregrine falcon (*Falco peregrinus*)

Birds Potentially Occurring at NAVSTA Roosevelt Roads (Continued)

Marbled godwit (*Limosa fedoa*)
Puerto Rican lizard cuckoo (*Saurothera vieillotii*)
Prothonotary warbler (*Protonotaria citrea*)
Green-winged teal (*Anas carolinensis*)
Orange-cheeked waxbill (*Estrilda melpoda*)
Least grebe (*Tachybaptus dominicus*)
West Indian whistling duck (*Dendrocygna arborea*)
Puerto Rican screech owl (*Otus nudipes*)
Puerto Rican tody (*Todus mexicanus*)

Source: U.S. Navy 1998b.

APPENDIX B

**Marine Resource Survey of SWMU Site
NAS Roosevelt Roads, Puerto Rico**

July 18, 2000

**Prepared for:
Geo-Marine, Inc.
Centro Punta Del Este, Suite 201
Fajardo, Puerto Rico 00738**

**Prepared by:
Dial Cordy and Associates Inc.
115 Professional Drive, Suite 104
Ponte Vedra Beach, FL 32082**

TABLE OF CONTENTS

	Page
LIST OF TABLES	II
1.0 INTRODUCTION.....	1
2.0 HABITAT DESCRIPTION	1
2.1 Rocky Subtidal Zone	1
2.2 Shallow Subtidal Shelf	4
2.3 Shelf Slope.....	4
2.4 Level Sandy Bottom	4
2.5 Outfall Structure	4
3.0 INDICATOR SPECIES	4
4.0 REFERENCES	6
APPENDIX A Photographs	

LIST OF TABLES

	Page
Table 1 Marine Flora and Fauna Observed at SWMU Site on June 19, 2000	2

1.0 INTRODUCTION

Dial Cordy and Associates Inc. conducted a reconnaissance survey of the SWMU 45 Site at NAS Roosevelt Roads on June 19, 2000. The marine biological survey was conducted for Geo-Marine, Inc. in support of their Ecological Risk Assessment for the installation. Objectives of the brief survey included defining the marine habitats and associated flora and fauna and identifying species observed which may be indicators of present conditions. Representative still photographs and video documentation of the site were also completed.

2.0 HABITAT DESCRIPTION

Marine habitats observed in the study area included a rocky-rubble subtidal zone located around most of the embayment, a shallow subtidal sandy shelf located seaward of the rocky shore, a shelf slope extending to the base of the slope, a deeper level bottom, and the outfall structure. A brief description of the biological communities observed within these habitat types is provided below.

2.1 Rocky Subtidal Zone

Rock rip-rap is located along the shoreline on both sides of the embayment, principally to serve as means of shore protection. The riprap extends from above MHW to approximately 3 feet below MLW. This rock habitat is occupied by a myriad of marine algal species attached to the rocks, as well as numerous sessile and motile epibiota and marine fish (Table 1, Photographs 1-4). Dominant algal species include *Halimeda tuna*, *H. opuntia*, *Penicillus pyriformis*, and *Udotea sp.* Common marine invertebrates observed included sea urchins (*Echinometra lucunter* and *E. viridis*), encrusting fire coral (*Millipora alcicornus*), common sea fan (*Gorgonia ventalina*), and starlet coral (*Siderastrea radians*). Sixteen species of marine fish were observed within the rocky zone. Many of these are species are more common to seagrass beds, but move to this zone for food and refugia from predators. Common species observed include sergeant major (*Abudefduf saxatilis*), dusky damselfish (*Stegastes fuscus*), tomtate (*Haemulon aurolineatum*), gray snapper (*Lutjanus griseus*), and squirrelfish (*Holocentrus sp.*). As shown in Table 1, 11 species of fish are classified as rarely observed. Of the 16 species observed, five were juveniles, which often reside in shallow interior seagrass beds or reefs during their earlier life stages, prior to moving to offshore reef environments upon reaching maturity.

Table 1 Marine Flora and Fauna Observed at SWMU Site on June 19, 2000

			Rocky Subtidal	Sandy Shelf	Shelf Slope	Outfall Structure
MARINE FLOWERING PLANTS						
	<i>Thalassia testudinum</i>		x	x	x	
	<i>Syringodium filiforme</i>			x		
ALGAE						
Green Algae						
	<i>Acetabularia calyculus</i>		x			
	<i>Penicillus pyriformis</i>		x			
	<i>Cladophora</i> sp.		x			x
	<i>Caulerpa sertularioides</i>		x			
	<i>Caulerpa racemosa</i>		x			x
	<i>Dictyosphaeria ocellata</i>		x			
	<i>Udotea</i> sp.		x	x	x	
	<i>Avrainvillea nigricans</i>		x			
	<i>Halimeda tuna</i>		x			
	<i>Halimeda opuntia</i>		x	x	x	
	<i>Penicillus capitatus</i>			x		
	<i>Halimeda incrassata</i>			x	x	
Brown Algae						
	<i>Dictyota cervicornis</i>		x			
	<i>Dictyopteris</i> sp.		x			
	<i>Padina</i> sp.		x	x	x	
Red Algae						
	<i>Wrangelia argus</i>		x			x
	<i>Laurencia papillosa</i>		x	x		
INVERTEBRATES						
c	<i>Cliona</i> sp.	red boring sponge	x			x
r	<i>Holopsamma</i> sp.	lumpy overgrowing sponge	x	x		
r	<i>Bartholomea annulata</i>	corkscrew anemone	x	x		
r	<i>Condylactis gigantea</i>	giant anemone	x			
c	<i>Millepora alcicornis</i>	branching fire coral	x			x
r	<i>Muricea elongata</i>	orange spiny sea rod				x
c	<i>Gorgonia ventalina</i>	common sea fan	x			x
c	<i>Leptogorgia</i> sp.	sea whip				x
c	<i>Siderastrea radians</i>	lesser starlet coral	x			x
c	<i>Sabellastarte magnifica</i>	feather duster	x			
r	<i>Cyphoma macgintyi</i>	spotted cyphoma	x			
r	<i>Oreaster reticulatus</i>	cushion sea star		x	x	
ab	<i>Echinometra lucunter</i>	rock boring urchin	x			
ab	<i>Echinometra viridis</i>	reef urchin	x			
r	<i>Actinopyga agassizii</i>	five-toothed sea cucumber		x	x	
c	<i>Holothuria mexicana</i>	donkey dung sea cucumber		x		
FISH						
r	<i>Chaetodon ocellatus</i>	spotfin butterflyfish	x			

			Rocky Subtidal	Sandy Shelf	Shelf Slope	Outfall Structure
r	<i>Pomacantus paru</i>	French angelfish (juv)	x			
r	<i>Acanthurus coeruleus</i>	blue tang (juv)	x			
r	<i>Sphyræna barracuda</i>	great baracuda		x		
c	<i>Gerres cinereus</i>	yellowfin mojarra (juv)		x	x	
r	<i>Archosargus rhomboidalis</i>	sea bream				x
c	<i>Calamus penna</i>	sheepshead porgy (adult)		x		
c	<i>Eucinostomus gula</i>	silver jenny (juv)		x	x	
c	<i>Haemulon aurolineatum</i>	tomtate (juv)	x	x		
c	<i>Lutjanus griseus</i>	gray snapper (juv)	x			x
r	<i>Lutjanus aoidus</i>	schoolmaster snapper	x	x		
c	<i>Stegastes fuscus</i>	dusky damselfish (adult)	x			x
r	<i>Stegastes leucostictus</i>	Beaugregory	x			
ab	<i>Abudefduf saxatilis</i>	sergeant major	x			x
r	<i>Serranus tigrinus</i>	harlequin bass	x			
r	<i>Sparisoma aurofrenatum</i>	redband parrotfish (juv)	x	x		
r	<i>Halichoeres bivittatus</i>	slippery dick	x	x		
c	<i>Holocentrus sp.</i>	squirrelfish	x			
r	<i>Coryphopterus glaucofraenum</i>	bridled goby	x			
r	<i>Aulostomus maculatus</i>	trumpetfish	x			
r	<i>Sphoeroides spengleri</i>	bandtail puffer	x			

r = rare
 ab = abundant
 c = common

2.2 Shallow Subtidal Shelf

This zone occurs between the rocky subtidal zone and the deeper shelf slope, from 3-10 feet below MSL. The shelf is characterized as a seagrass/ algal bed dominated by turtle grass (*Thalassia testudinum*) and marine algae including *Halimeda incrassata*, *H. opuntia*, *Udotea* sp., *Padina* sp., and *Penicillus capitatus*. (Photographs 5 & 8). Seagrass cover values based on the Braun Blanquet Method (Braun-Blanquet, 1965) ranged from 50% to greater than 75% for the turtle grass beds. Marine invertebrates observed included the pin cushion star fish (*Oreaster reticulatus*), sea cucumbers (*Actinopyga agassizii*, *Holothuria mexicana*), and the corkscrew anemone (*Bartholomea annulatta*) (Table 1). Fish common to the seagrass habitat included tomtate (*Haemulon aurolineatum*, gray snapper (*Lutjanus griseus*), and several species of mojarras.

The shelf area at the back end of the basin is a sandy bottom habitat with little to no seagrass or algae present. The bottom is covered with active mounds created by callianassid burrowing shrimp. Mojarras were the only family of fish observed in this area. An abundance of drift algae was observed covering the bottom.

2.3 Shelf Slope

The shelf slope ranged from 10-15 feet below MSL around the perimeter of the basin. This area was void of seagrass and characterized by marine algae including *Padina* sp, *Udotea* sp., and *Halimeda* spp (Photographs 7 & 8). No conspicuous motile epibenthic species were observed in this habitat. Fish observed included yellowfin mojarra (*Gerres cinereus*) and silver jenny (*Eucinostomus gula*).

2.4 Level Sandy Bottom

The interior of the basin from the mouth to and around the outfall structure is unvegetated sand to silty-sand bottom. Due to low visibility and depth (15-20 feet), no large invertebrates or fish were observed.

2.5 Outfall Structure

The concrete side walls of the outfall structure support a hardbottom community dominated by soft corals (*Leptogorgia* sp., *Muricea elongata*, *Gorgonia ventalina*), marine algae (*Caulerpa racemosa*, *Cladophora* sp.), sponges (*Cliona* sp.), and fire coral (*Millipora alcornus*). A list of species observed is provided in Table 1. Representative species are illustrated in Photographs 9 and 10.

3.0 INDICATOR SPECIES

Species which may serve as indicators of the present environmental quality of the site are listed below. The absence of seagrass and selected invertebrate species in the future would serve to indicate a change in the quality of the habitat and associated water quality in the embayment. Fish species selected are mobile and their absence may not reflect a significant change. The absence of many of the common species observed in association with the rocky shoreline would indicate a significant change had occurred.

Indicator Species	
<i>Thalassia testudinum</i>	turtle grass
<i>Condylactis gigantea</i>	giant anemone
<i>Echinometra viridis</i>	reef urchin
<i>Siderastrea radians</i>	lesser starlet coral
<i>Chaetodon ocellatus</i>	spotfin butterflyfish
<i>Stegastes fuscus</i>	dusky damselfish

4.0 REFERENCES

Braun-Blanquet, J. 1965. Plant sociology: the study of plant communities. Hafner Publications, London. 439p.

APPENDIX A

Photographs



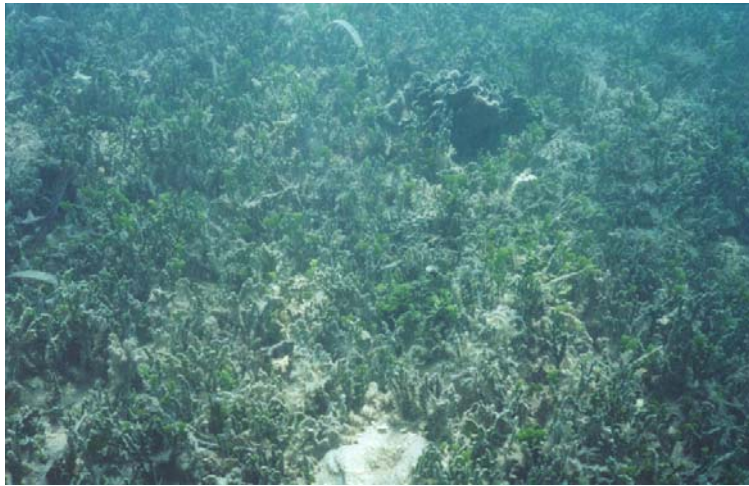
Photograph 1. Rocky subtidal habitat with squirrelfish (*Holocentrus adscensionis*).



Photograph 2. Rocky subtidal habitat and seagrass bed interface with calcareous green algae (*Halimeda incrassata*), turtle grass (*Thalassia testudinum*) and porous sea rods (*Pseudoplexaura sp.*).



Photograph 5. Seagrass habitat on shallow shelf dominated by turtle grass (*Thalassia testudinum*) and manatee grass (*Syringodium filiforme*).



Photograph 7. Shelf slope habitat characterized by green algae (*Halimeda incrassata* and *H. opuntia*).

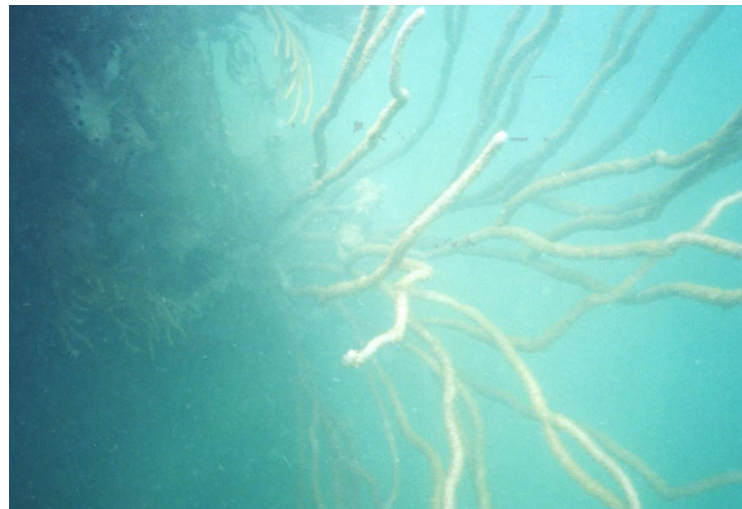
Photograph 6. Seagrass habitat with turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*) and green algae (*Halimeda incrassata*).



Photograph 8. Shelf slope habitat characterized by green algae (*Halimeda incrassata* and *H. opuntia*) and scattered turtle grass (*Thalassia testudinum*).



Photograph 9. Hard substrate community on outfall structure with red boring sponge (*Cliona* sp.) and feather duster worm.



Photograph 10. Gorgonian soft corals located on outfall structure.

APPENDIX B
TOXICITY TESTING LABORATORY SCOPE OF WORK

**28-DAY *EISENIA FETIDA* SURVIVAL, GROWTH, AND
REPRODUCTION TEST**

Scope of Work (SOW)

**Site 1 (Army Cremator Disposal - SWMU 1) and Site 2
(Langley Drive Disposal Site SWMU - 2)
Naval Activity Puerto Rico,
Ceiba, Puerto Rico
NAVY CLEAN III
Contract Task Order (CTO) 0108**

***Eisenia fetida* Chronic Toxicity Assay**

INTRODUCTION

The *Eisenia fetida* (Red Worm / Manure Worm) Chronic Assay will be used in a 28-d chronic assay to evaluate the effect of contaminants found in soil samples collected from Sites 1 and 2 of the Naval Activity, Ceiba, Puerto Rico. Common toxicity data endpoints of the bioassay are mortality, growth, reproduction, and bioaccumulation. The soil toxicity tests will be performed in accordance with ASTM Standard E-1676-04 (*Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia fetida and the Enchytraeid Potworm Enchytraeus albidus*). Methodology particular to Fort Environmental Laboratories (FEL) and CTO 0108 are described in the following paragraphs.

MATERIALS AND METHODS

APPARATUS

- Temperature controlled (22°C, \pm 3°C) chemical free room,
- Test vessels (500-1000 mL glass jars with ventilated lids, and
- Dissecting scope (10X or 15X power).

TEST MATERIAL

A maximum of 17 soil samples from each of two sites, including reference soils, will be collected from Sites 1 (SWMU – 1) and 2 (SWMU – 2) of the Naval Activity, Ceiba, Puerto Rico.

Sample Handling and Tracking

Samples will be shipped next day delivery to FEL via commercial carrier. Upon arrival, samples will be inventoried using the chain of custody. Temperatures will be recorded, along with signature and date, on the chain of custody. Samples will then be assigned appropriate tracking numbers and recorded in the sample check-in logbook. Tracking numbers will also be recorded on the individual sample bottles. Samples will be stored at 4°C throughout the testing and holding periods.

LABORATORY CONTROL

Laboratory prepared water, referred to as dechlorinated (DeCl₂) water, will be used with laboratory reference soil as the laboratory negative control and as the hydration water (if needed) if % moisture in any sample is below 25%. DeCl₂ water will be prepared by passing tap water through 3 filters; a 10" pre-treatment filter (5 µm) to remove solids, a 3.6 cf activated virgin carbon treatment filter to remove chlorine, ammonia, and higher molecular weight organics, and a 5 µm post-filter to remove any carbon particles from the carbon treatment phase.

TEST SYSTEM

Test species *E. fetida*, commonly known as red or manure worm, is readily available in nature and is easily cultured in the laboratory. The red worm has a short life-cycle consisting of 3 developmental phases: 1) cocoon phase, consisting of 1 to 10 eggs per cocoon; 2) immature phase, in which worms grow but can not reproduce; and 3) mature (adult) phase. The sensitivity of the red worm makes it a good indicator of toxicity in several types test media including soil, sediment, and sludge. Sexually mature, fully clitellate adults will be used at test initiation (d 0). *E. fetida* will be purchased from Aquatic Research Organisms (Hampton, NH) and shipped next day delivery to FEL.

Animal Handling and Feeding

Upon arrival at FEL, worms will be sorted and chosen for testing. Worms will not be fed during the 28-d assay. The red worm should be handled as little as possible to reduce stress to the organisms. Any worms injured or dropped while handling should be discarded.

STUDY DESIGN

Each treatment (site and reference soil samples) plus laboratory control will consist of 4 replicate 1 L glass jars containing 500 g of soil. Each soil sample will be homogenized prior to test setup by screening soils to remove foreign (non-soil) materials, i.e. glass, rocks, paper, wood, etc.), and then mixing each soil sample. The assay will be conducted in a temperature controlled room (22°C ± 3°) for 28 days. The study will receive continuous light over the 28 days with a light intensity ranging from 400-1,000 lux. Test jars will be examined at test termination (d 28) for survival, growth, and reproduction endpoints. Lids will be perforated for ventilation. Surviving worms will then be depurated for 24 h, reweighed, and frozen for bioaccumulation testing. An additional 4 replicates of each soil with 10 worms per jar will be setup on d 0 and maintained for 28 d along side the original test replicates to provide extra biomass for the bioaccumulation test. No data collection will be required on the additional replicates beyond d 28 and d 29 weights per replicate. Test specifications are outlined in Table 1.

Prior to Test Setup

Each treatment and control will be measured for pH, % moisture, and total organic carbon (TOC). Ideally, % moisture should range from 35% to 45% of the dry weight. If % moisture is below 25%, hydration of the sample may be necessary, with client approval. Use DeCl_2 water to hydrate samples, if required.

Study Day Minus 1

For each treatment, place 500 g of homogenized soil into each of 4 replicate test jars, plus an additional 4 biomass jars. Place test jars in the testing room with temperature controlled at 22°C , $\pm 3^\circ\text{C}$ for overnight equilibration. Test containers must be randomly distributed. Worms to be tested will be purged (no feeding) for 24 h prior to testing.

Study Day 0

Groups of 10 healthy, mature adult red worms with clitella will be rinsed in dechlorinated laboratory water, weighed as one biomass, and placed on top of the test material in each test jar located in the testing room. **An additional 20-30 adult worm background sample will be randomly chosen, weighed, and frozen for later tissue residue analysis to establish baseline data.** Measure room temperature and light intensity (lux).

Study Days 1 – 27

Test jars will be exposed to continuous light (400 – 1000 lux) throughout the assay. Room temperatures will be maintained at $22^\circ\text{C} \pm 3^\circ$. Temperature and light intensity will be measured and recorded daily.

Study Day 28

At test conclusion, the adult worms in each test jar will be counted to determine percent survival, and rinsed and weighed to determine mean growth. Mean reproduction will be determined by dividing the number of juveniles/cocoons by the number of surviving adults. Measure one replicate from each treatment and control for pH, % moisture, and TOC. Also, measure the room temperature and light intensity. Prepare worms (depurate for 24 h) for shipment to analytical laboratory for tissue residue analysis. Reweigh worms after depuration and freeze. Before and after depuration weights will also be required for the additional biomass replicates.

DATA COLLECTION

- Room temperature and light intensity – daily;
- % moisture, pH, and TOC – prior to day 0 and on day 28;
- Adult survival counts – day 28;
- Adult weights – days 0, 28, and 29 (after depuration); and
- Reproduction counts (juveniles plus cocoons) – day 28.

DATA ANALYSIS

Statistical calculations, including hypothesis testing, will be performed using SigmaStat® 2.03 statistical software (SPSS® Inc., Chicago, IL). All statistical evaluations will include comparison of site soil data for each endpoint to each individual reference and laboratory control.

AMENDMENTS AND DEVIATIONS

A permanent change to the study will require that a written amendment be prepared and approved by the Study Director prior to incorporation. The amendment will then be reviewed to determine the potential impact on the study. If accepted, the amendment will be attached to the SOW and become an active component of the study. Any deviations from the SOW (temporary changes due to unforeseen problems) will be recorded, dated, and initialed by the Study Director.

QA/QC REQUIREMENTS

Acceptable limits of mortality for the laboratory control (laboratory reference soil) will not exceed 20% for the assay. If acceptable limits are exceeded, the toxicity test will be repeated.

FINAL REPORTS

A separate report will be prepared for each SWMU and will be submitted within 21 calendar days from completion of the tests. Hardcopies of the final reports and electronic copies of the final reports (PDF) and raw data (PDF and excel) will be submitted to:

John Malinowski
Airside Business Park
100 Airside Drive
Moon Township, PA 15108
jmalowski@mbakercorp.com

The report, summarizing the results of the study will include but not limited to:

- Information on test organisms, to include age, source, and culturing conditions;
- Description of test conditions, to include temperature, photoperiod, test chamber size, surface soil/sediment volume, replicate number per treatment, number of organisms per vessel, and feeding regime;

- Results of soil measurements (pH, TOC, and percent moisture) and/or sediment pore water and overlying water measurements (ammonia and sulfide) for each SWMU and reference area sample and each laboratory control;
- Test organism survival, growth, and/or reproduction per sample and test replicate;
- Description and results of statistical evaluations comparing site surface soil to the laboratory control and reference surface soil samples; and
- Description of any amendments or deviations from approved methodology and any impacts this may have had to the data endpoints in this study.

STUDY LOGISTICS

RECORDS MAINTENANCE

Raw data, derived data, QA reports, correspondence, and final reports will be electronically maintained in computer files. Printed copies of this material will also be kept in designated file cabinets located in a secured file room at the study facility.

TEST SUBSTANCE DISPOSAL

Spent test materials will be disposed of in accordance with proper disposal requirements as outlined in FEL SOP 6.2.0.

MATERIALS ARCHIVAL

Data files, correspondence, QA records, and reports will be archived indefinitely. Storage of archived files will be maintained in a two-tier manner. Archived files will first be kept in file cabinets located in a secured file room at the laboratory facility for a period of 1 year or until final report has been reviewed and accepted by the client. After which time the files may be transferred to storage file boxes and archived off premises at a secured commercial storage facility. The preserved animal specimens will be labeled and archived in the laboratory until such time as the specimens are no longer needed or degradation over time renders the specimens useless.

GOOD LABORATORY PRACTICES (GLP)

Although this study will be conducted in the essence of the principles set forth in the Good Laboratory Practice (GLP) regulations (21 CFR 58, 1987), it is not intended to meet all the requirements of the GLP.

Table 1
Test Specifications

Test type	Fixed exposure system
Test species	<i>Eisenia fetida</i> (red worm)
Test initiation	Within 14 days from sample receipt
Species age (test setup)	Sexually mature adult with clitella
Feeding regime	Do not feed
Test duration	28 days
Test treatments	17 soils (including 3 reference sites)
Laboratory control	Laboratory reference soil
Replicates	4 per treatment; extra 4 for added biomass
Number of test animals	10 per replicate (80 per treatment)
Soil volume	500 g per test jar (4 Kg per treatment)
Test vessel	1 L glass jar with perforated lid
Light quality	Ambient laboratory
Light intensity	400 to 1000 lux
Photoperiod	Continuous light
Room temperature	22 ± 3°C
% moisture, pH, TOC	Days 0 and 28
Room temperature and light intensity	Daily
Survival counts	Day 28
Organism weights	Days 0 and 28; Day 29 after depuration
Reproduction counts (juveniles + cocoons)	Day 28
Test validation	≤ 20% mortality in control animals

**28-DAY *LEPTOCHEIRUS PLUMULOSUS* SURVIVAL GROWTH
AND REPRODUCTION TEST**

Scope of Work (SOW)

Site 1 (Army Cremator Disposal - SWMU 1) and Site 2
(Langley Drive Disposal Site SWMU - 2)
Naval Activity Puerto Rico,
Ceiba, Puerto Rico
NAVY CLEAN III
Contract Task Order (CTO) 0108

Leptocheirus plumulosus Chronic Toxicity Assay

INTRODUCTION

The *Leptocheirus plumulosus* (marine amphipod) Chronic Assay will be used in a 28-d chronic assay to evaluate the effect of contaminants found in sediment samples collected from Site 2 (SWMU - 2) of the Naval Activity, Ceiba, Puerto Rico. Common toxicity data endpoints of the bioassay are mortality, growth, and reproduction. The sediment toxicity tests will be performed in accordance with EPA 600/R01-020 (*Methods for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-Associated Contaminants with the Amphipod, Leptocheirus plumulosus*). Methodology particular to Fort Environmental Laboratories (FEL) and CTO 0108 are described in the following paragraphs.

MATERIALS AND METHODS

APPARATUS

- Temperature controlled (25°C, \pm 2°C) chemical free room,
- Test vessels (250-500 mL glass jars with ventilated lids, and
- Dissecting scope (10X or 15X power).

TEST MATERIAL

A maximum of 9 soil sediment samples from each of two sites, including reference soils, will be collected from Sites 1 (SWMU – 1) and 2 (SWMU – 2) of the Naval Activity, Ceiba, Puerto Rico.

Sample Handling and Tracking

Samples will be shipped next day delivery to FEL via commercial carrier. Upon arrival, samples will be inventoried using the chain of custody. Temperatures will be recorded, along with signature and date, on the chain of custody. Samples will then be assigned appropriate tracking numbers and recorded in the sample check-in logbook. Tracking numbers will also be recorded on the individual sample bottles. Samples will be stored at 4°C throughout the testing and holding periods.

LABORATORY CONTROL

Laboratory prepared water, referred to reconstituted seawater (RSW) water, will be used with laboratory reference sediment as the laboratory negative control. RSW source water will be prepared by passing tap water through 3 filters; a 10" pre-treatment filter (5 μ m) to remove solids, a 3.6 cf activated virgin carbon treatment filter to remove chlorine, ammonia, and higher molecular weight organics, and a 5 μ m post-filter to remove any carbon particles from the carbon treatment phase. Salts used to prepare RSW are described in EPA 600/R01-020 (*Methods for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-Associated Contaminants with the Amphipod, Leptocheirus plumulosus*).

TEST SYSTEM

Test species *L. plumulosus*, marine amphipod, is readily available in nature and is easily cultured in the laboratory. Neonatal organisms between 0.25 and 0.6 mm will be used at test initiation (d 0). *L. plumulosus* will be purchased from Aquatic Research Organisms (Hampton, NH) and shipped next day delivery to FEL.

Animal Handling and Feeding

Upon arrival at FEL, amphipods will be sorted and chosen for testing. The amphipods will be fed TetraMin flakes 2-3 times per week the 28-d assay. Any injured amphipods should be discarded.

STUDY DESIGN

Each treatment (site and reference soil samples) plus laboratory control will consist of 8 replicate 1 L glass jars containing 175 mL sediment. Each sample will be homogenized prior to test setup. The assay will be conducted in a temperature controlled room (25°C \pm 3°) for 28 days. The study will receive 16 h light: 8 h dark with a light intensity ranging from 500-1,000 lux. Test jars will be examined at test termination for mortality, growth, and reproduction endpoints. Lids will be perforated for ventilation. Test specifications are outlined in Table 1.

Study Day Minus 2

Determine salinity of pore water and acclimate cultures to overlying water salinity.

Study Day Minus 1

For each treatment, place 175 mL of homogenized sediment into each of 8 replicate test jars. Place test jars in the testing room with temperature controlled at 25°C, \pm 3°C for overnight equilibration. Test containers must be randomly distributed. Prepare vessels for dry weights 24 h prior to testing.

Study Day 0

Groups of 20 healthy neonates will be placed in each test jar located in the testing room. Water chemistry is measured, in addition to room temperature and light intensity (lux). Separate sets (3 groups of 20) neonates will be placed on tared filter paper and dried, and weighed (Study Day 1) as the initial weight.

Study Days 1 – 27

Test jars will be exposed to 16 h light and 8 h dark (500 – 1000 lux) throughout the assay. Room temperatures will be maintained at $25^{\circ}\text{C} \pm 3^{\circ}$. Temperature and light intensity will be measured and recorded. Organisms will be fed daily and checked 3 times per week. Approximately 400 mL of water will be siphoned off 3 times/week and replaced with fresh RSW prior to feeding.

Study Day 28

At test conclusion, the amphipods each test jar will be counted to determine mortality, and rinsed and weighed to determine growth. Measure one replicate from each treatment and control for vessel chemistry. The room temperature and light intensity will also be measured.

DATA COLLECTION

- Room temperature and light intensity – daily
- Chemistry – as directed
- Adult survival counts – day 28
- Adult weights – days 0 and 28

DATA ANALYSIS

Statistical calculations, including hypothesis testing, will be performed using SigmaStat® 2.03 statistical software (SPSS® Inc., Chicago, IL). All statistical evaluations will include comparison of site soil data for each endpoint to each individual reference and laboratory control and will follow the methods identified in Figure 1 of the SOW.

AMENDMENTS AND DEVIATIONS

A permanent change to the study will require that a written amendment be prepared and approved by the Study Director prior to incorporation. The amendment will then be reviewed to determine the potential impact on the study. If accepted, the amendment will be attached to the SOW and become an active component of the study. Any deviations from the SOW (temporary changes due to unforeseen problems) will be recorded, dated, and initialed by the Study Director.

QA/QC REQUIREMENTS

Acceptable limits of mortality for the laboratory control (laboratory reference soil) will not exceed 20% for the assay. If acceptable limits are exceeded, the toxicity test will be repeated.

FINAL REPORT

The hardcopy of the final report and electronic copies of the final report (PDF) and raw data (PDF and excel) will be submitted to:

John Malinowski
Airside Business Park
100 Airside Drive
Moon Township, PA 15108
jmalowski@mbakercorp.com

The report, summarizing the results of the study will include but not limited to:

- Information on test organisms, to include age, source, and culturing conditions;
- Description of test conditions, to include photoperiod, test chamber size, sediment volume, replicate number per treatment, number of organisms per vessel, and feeding regime;
- Results of overlying water physicochemistry;
- Results of pore water ammonia and sulfide chemistry;
- Test endpoints, to include survival and growth data;
- Description and results of statistical evaluations comparing site sediment to references and laboratory control; and
- Description of any amendments or deviations from approved methodology and any impacts this may have had to survival and growth in this study.

STUDY LOGISTICS**RECORDS MAINTENANCE**

Raw data, derived data, QA reports, correspondence, and final reports will be electronically maintained in computer files. Printed copies of this material will also be kept in designated file cabinets located in a secured file room at the study facility.

TEST SUBSTANCE DISPOSAL

Spent test materials will be disposed of in accordance with proper disposal requirements as outlined in FEL SOP 6.2.0.

MATERIALS ARCHIVAL

Data files, correspondence, QA records, and reports will be archived indefinitely. Storage of archived files will be maintained in a two-tier manner. Archived files will first be kept in file cabinets located in a secured file room at the laboratory facility for a period of 1 year or until final report has been reviewed and accepted by the client. After which time the files may be transferred to storage file boxes and archived off premises at a secured commercial storage facility. The preserved animal specimens will be labeled and archived in the laboratory until such time as the specimens are no longer needed or degradation over time renders the specimens useless.

GOOD LABORATORY PRACTICES (GLP)

Although this study will be conducted in the essence of the principles set forth in the Good Laboratory Practice (GLP) regulations (21 CFR 58, 1987), it is not intended to meet all the requirements of the GLP.

Table 1
Test Specifications

Test type	Static-renewal exposure system
Test species	<i>L. plumulosus</i> (marine amphipod)
Test initiation	Within 14 days from sample receipt
Species age (test setup)	< 48-h old neonates
Feeding regime	Day 0-13 20 mg; Day 14-28 40 mg TetraMin/chamber
Test duration	28 days
Test treatments	9 sediments (including reference sites)
Laboratory control	Laboratory reference soil
Replicates	8 per soil treatment
Number of test animals	20 per replicate (160 per treatment)
Sediment volume	175 mL per test jar
Test vessel	1 L glass jar
Light quality	Ambient laboratory
Light intensity	500 to 1000 lux
Photoperiod	16 h light:8 h dark
Room temperature	25 ± 3°C
pH and observations	3 times per week
DO, room temperature and light intensity	Daily
Survival counts	Day 28
Organism weight	Day 0 and 28
Reproduction	Day 28
Test validation	≤ 20% mortality in control animals

**20-DAY *NEANTHES ARENACEODENTATA* SURVIVAL AND
GROWTH TEST**

Scope of Work (SOW)

**Site 1 (Army Cremator Disposal - SWMU 1) and Site 2
(Langley Drive Disposal Site SWMU - 2)
Naval Activity Puerto Rico,
Ceiba, Puerto Rico
NAVY CLEAN III
Contract Task Order (CTO) 0108**

***Neanthes arenaceodentata* Chronic Toxicity Assay**

INTRODUCTION

The *Neanthes arenaceodentata* (marine polychaete worm) Chronic Assay will be used in a 20-d chronic assay to evaluate the effect of contaminants found in sediment samples collected from Site 2 (SWMU - 2) of the Naval Activity, Ceiba, Puerto Rico. Common toxicity data endpoints of the bioassay are mortality and growth. The sediment toxicity tests will be performed in accordance with ASTM Standard E-1562-00 (*Standard Guide for Conducting Acute, Chronic, and life-Cycle Aquatic Toxicity Tests with Polychaetous Annelids*). Methodology particular to Fort Environmental Laboratories (FEL) and CTO 0108 are described in the following paragraphs.

MATERIALS AND METHODS

APPARATUS

- Temperature controlled (20.0°C, \pm 1°C) chemical free room,
- Test vessels (500 mL vessels), and
- Dissecting scope (10X or 15X power).

TEST MATERIAL

A maximum of 9 sediment samples from each of two sites, including reference soils, will be collected from Sites 1 (SWMU – 1) and 2 (SWMU – 2) of the Naval Activity, Ceiba, Puerto Rico.

Sample Handling and Tracking

Samples will be shipped next day delivery to FEL via commercial carrier. Upon arrival, samples will be inventoried using the chain of custody. Temperatures will be recorded, along with signature and date, on the chain of custody. Samples will then be assigned appropriate tracking numbers and recorded in the sample check-in logbook. Tracking numbers will also be recorded on the individual sample bottles. Samples will be stored at 4°C throughout the testing and holding periods.

LABORATORY CONTROL

Laboratory prepared water, referred to reconstituted seawater (RSW) water, will be used with laboratory reference sediment as the laboratory negative control. RSW source water will be prepared by passing tap water through 3 filters; a 10" pre-treatment filter (5 µm) to remove solids, a 3.6 cf activated virgin carbon treatment filter to remove chlorine, ammonia, and higher molecular weight organics, and a 5 µm post-filter to remove any carbon particles from the carbon treatment phase. Salts used to prepare RSW are described in ASTM Standard E-1562-00 (*Standard Guide for Conducting Acute, Chronic, and life-Cycle Aquatic Toxicity Tests with Polychaetous Annelids*).

TEST SYSTEM

Test species, *N. arenaceodentata*, commonly known as marine polychaete worm, is readily available in nature and is easily cultured in the laboratory. *N. arenaceodentata* will be purchased from Aquatic Research Organisms (Hampton, NH) and shipped next day delivery to FEL.

Animal Handling and Feeding

Upon arrival at FEL, worms will be sorted and chosen for testing. Worms will be fed every other day during the 20-d assay. The polychaete worms should be handled as little as possible to reduce stress to the organisms. Any worms injured or dropped while handling should be discarded.

STUDY DESIGN

Each treatment (site and reference soil samples) plus laboratory control will consist of 8 replicate 1 L vessels containing 175 mL of sediment. Each sediment sample will be homogenized prior to test setup. The assay will be conducted in a temperature controlled room ($19^{\circ}\text{C} \pm 1^{\circ}\text{C}$) for 20 days. The study will receive continuous light over the 28 days with a light intensity ranging from 500-1,000 lux. Test jars will be examined at test termination for mortality and endpoints. Lids (if used) will be perforated for ventilation. Test specifications are outlined in Table 1.

Study Day Minus 2

Each treatment and control pH and total organic carbon (TOC) will be measured.

Study Day Minus 1

For each treatment, place 175 mL of homogenized sediment into each of 8 replicate test jars. Place test jars in the testing room with temperature controlled at $19^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for overnight equilibration. Test containers must be randomly distributed.

Study Day 0

Groups of 10 healthy worms will be rinsed in dechlorinated laboratory water, weighed as one biomass, and placed in each test jar located in the testing room. Measure room temperature and light intensity (lux).

Study Days 1 – 19

Test jars will be exposed to continuous light (500 – 1000 lux) throughout the assay. Room temperatures will be maintained at $19^{\circ}\text{C} \pm 1^{\circ}\text{C}$. Temperature and light intensity will be measured and recorded.

Study Day 20

At test conclusion, the adult worms in each test jar will be counted to determine mortality, and rinsed and weighed to determine growth. Measure one replicate from each treatment and control for pH, % moisture, and TOC. Also, measure the room temperature and light intensity.

DATA COLLECTION

- Room temperature and light intensity – daily;
- % moisture, pH, and TOC – days 0 and 20;
- Adult survival counts – day 20; and
- Adult weights – days 0 and 20

DATA ANALYSIS

Statistical calculations, including hypothesis testing, will be performed using SigmaStat® 2.03 statistical software (SPSS® Inc., Chicago, IL). All statistical evaluations will include comparison of site soil data for each endpoint to each individual reference and laboratory control.

AMENDMENTS AND DEVIATIONS

A permanent change to the study will require that a written amendment be prepared and approved by the Study Director prior to incorporation. The amendment will then be reviewed to determine the potential impact on the study. If accepted, the amendment will be attached to the SOW and become an active component of the study. Any deviations from the SOW (temporary changes due to unforeseen problems) will be recorded, dated, and initialed by the Study Director.

QA/QC REQUIREMENTS

Acceptable limits of mortality for the laboratory control (laboratory reference soil) will not exceed 20% for the assay. If acceptable limits are exceeded, the toxicity test will be repeated.

FINAL REPORT

The hardcopy of the final report and electronic copies of the final report (PDF) and raw data (PDF and excel) will be submitted to:

John Malinowski
Airside Business Park
100 Airside Drive
Moon Township, PA 15108
jmalowski@mbakercorp.com

The report, summarizing the results of the study will include but not limited to:

- Information on test organisms, to include age, source, and culturing conditions;
- Description of test conditions, to include photoperiod, test chamber size, sediment volume, replicate number per treatment, number of organisms per vessel, and feeding regime;
- Results of overlying water physicochemistry;
- Results of pore water ammonia and sulfide chemistry;
- Test endpoints, to include survival and growth data;
- Description and results of statistical evaluations comparing site sediment to references and laboratory control; and
- Description of any amendments or deviations from approved methodology and any impacts this may have had to survival and growth in this study.

STUDY LOGISTICS**RECORDS MAINTENANCE**

Raw data, derived data, QA reports, correspondence, and final reports will be electronically maintained in computer files. Printed copies of this material will also be kept in designated file cabinets located in a secured file room at the study facility.

TEST SUBSTANCE DISPOSAL

Spent test materials will be disposed of in accordance with proper disposal requirements as outlined in FEL SOP 6.2.0.

MATERIALS ARCHIVAL

Data files, correspondence, QA records, and reports will be archived indefinitely. Storage of archived files will be maintained in a two-tier manner. Archived files will first be kept in file cabinets located in a secured file room at the laboratory facility for a period of 1 year or until final report has been reviewed and accepted by the client. After which time the files may be transferred to storage file boxes and archived off premises at a secured commercial storage facility. The preserved animal specimens will be labeled and archived in the laboratory until such time as the specimens are no longer needed or degradation over time renders the specimens useless.

GOOD LABORATORY PRACTICES (GLP)

Although this study will be conducted in the essence of the principles set forth in the Good Laboratory Practice (GLP) regulations (21 CFR 58, 1987), it is not intended to meet all the requirements of the GLP.

Table 1
Test Specifications

Test type	Static-renewal exposure system
Test species	<i>N. arenaceodentata</i> (polychaete worm)
Test initiation	Within 14 days from sample receipt
Species age (test setup)	1-3 months
Feeding regime	8 mg TetraMin/worm ca. every other day
Test duration	20 days
Test treatments	9 sediments (including reference sites)
Laboratory control	Laboratory reference soil
Replicates	8 per soil treatment
Number of test animals	10-20 per replicate (80-160 per treatment)
Sediment volume	175 mL per test jar
Test vessel	500 mL - 1 L glass jar
Light quality	Ambient laboratory
Light intensity	500 to 1000 lux
Photoperiod	12 h light:12 h dark
Room temperature	20 ± 1°C
pH and observations	3 times per week
DO, room temperature and light intensity	Daily
Survival counts	Day 20
Organism weight	Day 0 and 20
Test validation	≤ 20% mortality in control animals

APPENDIX C
FIELD NOTES

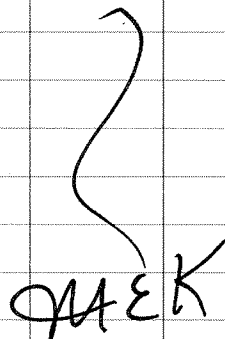
Mark Kimes – Professional Engineer

(51)

26 FEBRUARY 2007

SUMMS 1 & 2 SITE VERIFICATION

MOBILIZED TO PR.



MARK

27 FEBRUARY 2007

(52)

0615 ARRIVED AT NAAP. WENT TO PWD
TO UNPACK AND PREPARE FOR SAMPLING
AT SUMMS 1 & 2.

0820 DEPART PWD FOR SUMMS 1 TO COLLECT SURFACE
SOIL SAMPLES.

0902 COLLECTED 1VSS01 w/ SS spoon FOR TOC,
PH & GRAIN SIZE. SOIL WAS DRY w/ SOME
ROCK.

0917 COLLECTED 1VSS02 w/ SS spoon FOR
TOC, PH & GRAIN SIZE. SOIL DRY WITH
LARGE AMOUNT OF ROCK.

0924 COLLECTED 1VSS03 w/ SS spoon FOR
TOC, PH & GRAIN SIZE. SOIL DRY WITH
DARK BROWN COLOR. LARGE AMT. OF ROOTS.

0937 COLLECTED 1VSS04 w/ SS spoon FOR TOC,
PH and GRAIN SIZE. SOIL DRY WITH LARGE
AMT. OF ROOTS/ROCK.

0959 COLLECTED 1VSS05 WITH SS spoon FOR TOC,
PH, and GRAIN SIZE. SOIL DRY WITH
SOME ROCK.

1014 COLLECTED 1VSS06 w/ SS spoon FOR TOC,
PH and GRAIN SIZE. SOIL WAS SOMEWHAT
DRY WITH GRAVEL and ROOTS.

1028 DEPART SUMMS 1 FOR SUMMS 2 TO OBTAIN
SURFACE AND SUBSURFACE SOIL SAMPLES.

(53)

27 FEBRUARY 2007

- 1103 Collected 2VSS01 w/ ss spoon
for TOC, pH and Grain size. Soil was
dry with some rock and roots
- 1113 Collected 2VSS02 w/ ss spoon for
TOC, pH and grain size. Soil dry with
some rock and small roots
- 1120 Collected 2VSS03 with ss spoon for
TOC, pH and grain size. Soil dry with
some rock and roots.
- 1147 Collected 2VSB02 w/ ss spoon
for TOC, pH and grain size. Soil was
moist with some rock.
- 1158 Collected 2VSB01 w/ ss spoon for
TOC, pH and grain size. Soil was moist
with some rock.
- 1213 Collected 2VSB03 w/ ss spoon for
TOC, pH and grain size. Soil was moist
some rock.
- 1400 Collected 2VSS06 w/ ss spoon for
TOC, pH and grain size. Soil was dry
with roots and small rock.
- 1403 Collected 2VSS05 w/ ss spoon for
TOC, pH and grain size. Soil was dry
with roots / rock.
- 1407 Collected 2VSS04 with ss spoon
for TOC, pH and grain size. Soil
dry.

27 FEBRUARY 2007

(54)

- 1439 Collected 2VSB04 w/ ss spoon
for TOC, pH and grain size. Soil
was moist. Iguana nests in the area
- 1445 Collected 2VSB05 w/ ss spoon
for TOC, pH and grain size. Soil was
moist with some rock. Iguana nests
in the immediate area.
- 1455 Collected 2VSB06 w/ ss spoon
for TOC, pH and grain size. Soil moist
with rock.
- 1510 DEPARTED FOR PWD
- 1610 Collected 1U-ERO1 for IL-PATH,
APP Pesticides / METALS
(STAINLESS STEEL SPOON)
- 1620 Collected 1U-FB01 for IL-PATH,
APP Pesticides / METALS

(55)

28 February 2007

0620 Arrived at NAPP/PWD. Gathered
Necessary Equipment & Supplies
To Collect Reference Area Surface
Soil Samples.

0715 Depart PWD for Reference Area

0752 Collected REF-SS01, REF-SS01D and
REF-SS01 MS/MSD, For LL-PAH's,
APP IX Pesticides, APP IX Metals,
TOC, Grain Size and pH.

* [ss/spoon utilized for each collection]
(All samples)

- Soil mostly dry with rock throughout

0801 Collected REF-SS02 - For LL-PAH's,
APP IX Metals and APP IX Pesticides,
TOC, Grain Size and pH.
- Soil mostly dry with some rock.

0815 Collected REF-SS03 / REF-SS03D
For (Sb, Cd, Cu, Pb, Hg, Sn, Zn) and
4,4' DDD/DDE/DDT, TOC, Grain Size
and pH.

Soil mostly dry with rock

28 February 2007

(56)

0823 Collected REF-SS04 For (Sb, Cd, Cu,
Pb, Hg, Sn, Zn) and 4,4' DDD/DDE/DDT
TOC, Grain Size and pH.
Soil mostly dry with some rock.

0845 Collected REF-SB01, SB01D and
SB01 MS/MSD For LL-PAH
APP IX Pesticides and APP IX Metals,
TOC, Grain Size and pH.
~~Soil mostly~~ Soil moist.

0855 Collected REF-SB02
(Same Parameters as above)
Rock observed throughout sample.

0900 Collected REF-SB03 For (Sb, Cd, Cu,
Pb, Hg, Sn, Zn) 4,4' DDD/DDE/DDT, TOC,
Grain Size and pH.
Soil somewhat moist with rock

0904 Collected REF-SB04
(Same Parameters as above)
Soil somewhat moist - rock throughout.

0930 Collected REF-SS05 For LL-PAH,
APP IX Pesticides, APP IX Metals, TOC,
Grain Size and pH.
Soil dry with tiny roots and rock.

0940 Collected REF-SS06
(Same Parameters as above)
Soil mostly dry with rock throughout.

0944 Collected REF-SB06

(57)

28 February 2007

1002 Collected REF-SS07 For
(Sb, Cd, Cu, Pb, Hg, Sn, Zn), 4,4'DDP/
PDE/DDT, TOC, Grain Size and pH.
Soil mostly dry with rocks.

1006 Collected REF-SB07
(Same parameters as above)
Soil dry with rocks

1016 Collected REF-SS08
(" ")
Soil dry with rocks and roots in
A-later.

1020 Collected REF-SB08
(" ")
Soil dry with some rocks and
vegetative roots throughout.

1141 Collected REF-SS09 For APP IX
Pesticides, APP IX Metals, LL-PATH's,
TOC, Grain Size and pH.
Soil was observed to be dry
with some rocks encountered while
sampling.

28 February 2007

(58)

1145 Collected REF-SS09
(Same parameters as REF-SS09)
Soil was observed as dry

1202 Collected REF-SS09
Soil dry with small rocks.

1206 Collected REF-SB10
(" ")
Soil observed as dry to partly
moist. Rock throughout.

1217 Collected REF-SS011 For (Sb,
Cd, Cu, Pb, Hg, Sn, Zn), 4,4'DDP/
PDE/DDT, TOC, Grain Size and pH.
Soil mostly dry with rocks.

1221 Collected REF-SB11
(Same parameters as above)
Soil was moist with a rock and
roots throughout

1233 Collected REF-SS012
(" ")
Soil was mostly dry with roots
and rock throughout

1237 Collected REF-SB12
(" ")
Soil was somewhat moist with rock/some roots

1341 Departed REF area for DPW. Unpack and
gathered add'l supplies for continued sampling.

1525 EWSD01
Collected 2U-~~REF-SS013~~ For ~~APP IX~~
Pesticides, APP IX Metals, LL-PATH's,
TOC, Grain Size and pH. Soil matrix
observed as saturated/silty/low-chroma.

(59)

All Samples below include parameters
for Sulfide & Ammonia, TOC, Grain Size and pH

February 28 2007

1529 Collected 2U-EWSD02

Soil observed as silty matrix
with low-chrome colors. Soil saturation
evident.

1534 Collected 2U-EWSD03

Saturated soil observed as
silty matrix with low-chrome colors.

1540 Collected 2U-EWSD04

Saturated soil observed as silty
matrix with low-chrome colors.

1547 Collected 2U-EWSD05

Saturated soil observed as silty
matrix with low-chrome colors.

1563 Collected 2U-EWSD06

Saturated soil observed as
silty matrix with low-chrome
colors.

1630 Collected 2U-EP01 For U-PATH,

HP IX, Pesticides/Metals
(Budget Auger)

March 1 2007

(60)

0630 Arrived at MTR / DPW. Gathered
supplies / camp for sampling.

0725 Depart for Estuarine Wetland sample
area.

0752 Collected REF-EWSD01 / REF-EWSD02
REF-EWSD03 / MSD FOR
Cu, Pb, Hg, Zn, ammonia Sulfide,
TOC, Grain Size and pH
Soil was saturated with a silty/
low-chrome matrix. All samples collected
with stainless steel spoon.

0804 Collected REF-EWSD02
Soil was saturated with a silty/
low-chrome matrix.

0811 Collected REF-EWSD03
Soil was saturated with a silty/
low-chrome matrix.

0818 Collected REF-EWSD04
Soil was saturated with a silty/
low-chrome matrix.

0826 Collected REF-EWSD05
Soil was saturated with a silty/
low-chrome matrix.

0839 Collected REF-EWSD06
Soil was saturated with a silty/
low-chrome matrix.

0912 Depart reference wetland area for
DPW.

⑥1

March 1 2007

0927

Prepared all sample containers
for shipment to lab. Also, At this
time, collected ~~20~~ ¹⁰ ~~REF~~ REF-Eld
using a ~~2~~ Stainless steel
spoon (collected at 1605)

1711

Depart NAPR for SAN Juan, PR.

Joseph Burawa – Environmental Geologist

①

5/18/07

710

2B-SS11

Sandy Silt, dry, roots,
pebbles & rocks, med soft
little clay, glass med brown

715

2B-SS12

Silt Loam, dry, damp
some clay, rocks, med soft
many roots, med brown

720

2B-SS13

Clay loam to 0.7' the sand
& gravel, moist, med brown
rocks, weathered limestone

(2)

725 2B-5514

Dip & ms/msd collected
dry, med brown, many roots,
rocks, silty loam

736 2B-5515

clay loam, damp to moist
med brown, rocks, roots, rocks

735 2B-5516

Sandy loam, weathered rock
and sand at 0.8', damp
med brown, rocks, roots

740 2B-5517

Sandy clay loam, roots, rocks
med soft, med brown

(3)

5/18/07

745 2B-5518

clay loam, Dark brown, root
rocks, med soft

750 2B-5519

~~Sandy~~ Clay Loam JAS
med to Dark Brown, med soft
damp, roots, rocks, rocks,
metal, shells, and sand @
bottom

755 2B-5520

Sandy loam, med brown
med soft, roots (lots w/ 1st 6")
metal, debris, med soft

④

800 2B-5521

Clay loam, mod soft,
med brown, damp, roots
rock, some debris

805 2B-5522

Sandy loam mod soft
med brown, damp to dry
roots throughout, wood, coral
fragments

810 2B-5523

Sandy loam, mod soft,
dark brown, damp, rocks
some debris

⑤

5/18/01

815 2B-5524

Sandy loam, dark brown
mod soft, roots, damp to dry
Dug & ms/msd collected

820 2B-5525

Sandy loam, med brown
mod soft, roots, damp to dry

(Mounding in Area)
825 2B-5526

Sandy loam, med brown
mod soft, roots, rocks
shell frags, damp to dry
2B-5527

830 Sandy loam mod brown
mod soft, roots, rocks
damp to dry

⑥

835 2B-5529

Sandy loam, roots, rock
dark brown, mod soft
damp to dry

840 2B-5530

Sandy loam, med brown
rocks, roots, mod soft
wood frags, shell frags
damp to dry

845 2B-5528

Silty loam, mod to lt. brown
rocks, roots, mod hard, damp
to dry

⑦

5/18/07

1225 2B-5531

Sandy loam, Iron staining, copper
wire, hard, damp, rocks, strange
musty odor, glass, metal debris

1230 2B-5532

Sandy loam, Rusty brown color
iron staining, damp, hard, rocks
metal, glass

1235 2B-5533

Dark Brown Sandy loam, glass
large metal debris, damp
some clay, rocks

1240 2B-5534

Sandy loam, med brown, mod.
hard, metal, some clay, roots
damp

8

1245 2B-5535

Sandy loam, med gray brown,
damp, mod hard, roots, metal
debris, wood frags

1250 2B-5536

Sandy loam, dark brown, damp
mod hard, roots, wood frags
metal frags,

1255 2B-5537

Clay loam, dark brown, damp
mod hard, many roots,

1300 2B-5538

Silty loam, dark brown, damp
mod hard, roots, black debris
roots

9

5/18/07

1305 2B-5539

Sandy loam, roots, dark brown
black debris, leaflike, mod
hard, rocks,

1315 2B-5540

Sandy loam, dark brown,
damp to dry, roots, rocks,
mod hard, glass, metal debris

original ss03

1330 2B-5501

Sandy loam, dark brown,
mod hard, damp to dry,
metal debris, rocks

2B-5501

Sand with some clay, light brown
damp to moist, loose, rocks

1345 2B-5500
Silty loam, dark brown,
damp, mod hard, roots

(10)

1345 2B-SS02

Sandy clay, med branny, damp to moist, mod soft, rocks, roots, metal debris

2B-SS02

Clayey Sand, light brown, damp to moist, mod soft, rocks

1400 2B-SS04

Sandy Clay mod soft, damp to moist, rocks, roots
dup & ms/msd collected

2B-SS04

Clayey sand, mod soft, moist to wet, roots, rocks, brownish gray

(11)

5/18/07

1415

2B-SS03

No subsurface soil collected

Sandy loam, mod ~~hard~~ ^{hard} ~~soft~~, metal debris throughout, iron staining damp to dry, roots, rocks

1430

2B-SS05

Sandy loam, mod hard metal debris throughout, iron staining, damp to dry, roots, rocks

No subsurface soil collected.

1515

2B-SS06

Sandy loam, med brown, loose damp.

2B-SS06

Sandy loam, med brown, loose damp

⑫

1520 2B - 5507

Sandy clay, med brown, med
soft, damp roots

2B - 5B07

Sandy clay and red clay
stiff, med hard, damp

1530 2B - 5508

Med gray sandy clay, med
soft, damp

2B - 5B08

Med to Dark gray brown, clay
stiff, damp to moist,

1545 2B - 5509

Sandy loam, med brown
damp to dry, roots

2B - 5B09

Sandy loam, med brown
damp, med hard, roots

⑬

5/18/07

1600 2B - 5510

Sandy ~~clay~~ loam, med brown
mod soft, roots, damp

2B - 5B10

Sandy clay, med to dark brown
mod hard, roots, damp

25B03

↓

1610 2B - 5541

Silty clay, dark Brown, dry
soft, loose, roots

1615 2B - 5542

Silty clay, dark Brown, dry
soft, loose, roots

1620 2B - 5543

Silty loam, damp, dark Brown
soft loose, roots, rocks

(14)

1625 2B-5544

Sandy loam, med brown, damp
decaying roots, rocks
some metal debris
duplicate collected.

1630 2B-5545

Silty loam, dark brown
damp, roots, wood, metal
and concrete debris.

1645 2B-5546

Sandy clay, dark brown
damp, chunky, roots, rocks

(15)

5/18/07

1650 2B-5547

Sandy clay, dark brown
damp, chunky, roots, rocks

1655 2B-5548

Sandy clay, med brown
damp, med hard, roots, rocks

1700 2B-5549

Sandy clay, dark brown
damp, med. hard, roots
rocks, concrete debris

1705 2B-5550

Sandy clay, dark brown
damp, med hard, roots, rocks
iron-staining

(16)

(17)

5/19/07

2B-EWSD 01

730

light brown sand (medium-grained)
at top 1/4" the light gray
sandy clay, moist to wet,
thin organic layer (black)

2B-EWSD 02

750

light brown silt and clay,
black organic layer at surface,
wet, roots

2B-EWSD 03

810

light olive brown silty clay
mottling, wet, black organic
layer at surface, roots

18

2B-EWSD04 830

Dip = MS/MSD collected
light gray silt and clay,
shell frags wet, soft
black organic layer @ surface
very soft, roots

2B-EWSD05 850

Dark grayish brown, silty clay
black organic layer @ surface
very soft, wet, roots

2B-EWSD06 910

Dark grayish brown Silty clay
Black organic layer @ surface
very soft, wet, roots

19

5/19/07

2B-EWSD07 930

Silt and Clay, med grayish brown
and white clay, soft, wet, roots
black organic layer at surface.

2B-EWSD08 950

Light brown clay, some silt
mottling, shell frags, very soft
wet, black organic layer @ surface
roots

2B-EWSD09 1020

Medium brown, Sandy clay
roots, rocks, med grained sand
med soft, moist, debris (metal)
in area.

(20)

2B - EWSD 10 1040

*Dark olive brown, clay and silt,
mangrove roots, very soft, wet
black organic layer.

2B - EWSD 11 1055

Dark gray silt with some clay
mangrove roots, very soft, wet
black organics

2B - EWSD 12 1120

Dark brown silt, roots,
very soft, wet, black organics,
some clay

(21)

2B - EWSD 13 1335

Dark brown, silt, some clay,
very soft, wet, mangrove roots
black organics

2B - EWSD 14 1325

Dark grayish brown, silt and
clay, soft, wet, mangrove roots
black organics
Duplicate sampled

2B - EWSD 15 1315

Med gray brown, silty clay,
some clay, moist to wet, roots
soft, black organics

22

2B - EWSD 16 1300

Med brown, Sandy clay,
mod hard, damp to dry, roots
rocks

2B - EWSD 17

Sample not collected due to
location being more representative
of upland soils, not wetland.

2B - EWSD 18 1350

DARK olive brown, Silt, some
clay, mangrove roots, wet, soft
black organics

23

2B - EWSD 19 1410

DARK olive brown, Silt, some
clay, mangrove roots, wet soft
black organics

2B - EWSD 20 1425

DARK brown, Silt, mangrove
roots, wet, soft, some clay
black organics

2B - EWSD 21 1440

DARK brown, Silt, mangrove
roots, wet, soft, black
organics, some clay

(24)

2B - EWSD 22 1500

Dark brown, Silt
wet, soft, black organics
mangrove roots, some clay

2B - EWSD 23 1520

Medium olive brown, Silt
and ~~sand~~ ^{clay}, soft, wet black
organics, mangrove roots

2B - EWSD 24 1545

Medium Brown, sandy clay,
shell frags, mud soft, damp
rocks, roots

(25)

5/20/07

Estuarine Wetland
Reference Sediment

REF

2B - EWSD - 01 930

Organic Matter, mangrove
root mass, med to dark brown
lighter at 2" Silty Clay

2B - REF EWSD 02 950

Organic Matter on top, mangrove
roots, med brown, lighter at
2" Silty Clay

2B - REF EWSD 03 1010

Organic matter at the surface
mangrove roots, med to light brown
silty clay

(26)

2B-REFEWS-04 ~~1020~~ 1020

Silty clay, light gray brown
soft, organic matter at surface,
mangrove root matter.

Dip & ms/msd collected.

2B-REFEWS-05 ~~1045~~ 1045

Silty Clay, light gray brown
organic first 1/2" mangrove
root matter, soft

2B-REFEWS-06 ~~1105~~ 1105

Silty clay, light brown with
dark brown organics on the
surface, mangrove root matter

(27)

5/20/67

2B-REFSS01 (1315)

Clay loam, Med Brownish/gray
Med soft, damp, some rocks,
roots

2B-REFSB01 (1320)

Sandy Clay loam, moist to wet
soft, some stones

2B-REFSS02 1340

Clay loam med brown and gray
med soft, 'some rocks at 0.6'
roots damp to moist

(28)

2B-REFSB02 1350

Silty clay med gray brown
very soft, some fine to med grained
sand from 1.1 to 1.3', moist to
wet. sticky

2B-REFSS03 (1320)

Silty Clay DARK Grayish Brown
damp, med soft, roots, rocks
mottling

2B-REFSB03 (1325)

Clay with some silt, moist to
wet, very soft, sticky

(29)

5/20/07

2B-REFSS04 1330

Clay loam, med brown, med
soft, damp to moist, roots,
rocks, mottling

2B-REFSB04 1340

Silty clay, med grayish brown,
very soft, moist to wet.
rocks.

2B-REFSS05 1400

Sandy clay loam, med brown,
med soft, roots, rocks, damp

(30)

ZB-REFSB05 1415

Silty clay, med grayish brown
very soft, sticky, occasional
rock, moist to wet.

ZB-REFSS06 1410

Clay loam, med brown, roots
rocks, mod. soft, damp

ZB-REFSB06 1430

Silty clay, med gray brown,
very soft, sticky, some sand
occasional rocks

5/21/07

(31)

Fiddler Crab Collection Activities Estuarine Wetland Reference Area

4 Crab composite Samples
6 Grabs/composite

Ref-FC-01

collected 12:15 to 12:47 PM

REF-FC-02

collected from 12:55 to 1:15 PM

REF-FC-03

collected from 1:24 to 1:39 PM

REF-FC-0304 ^{5/21/07}

collected from 1:48 to 2:15 PM

[Signature]

62

63

5/22/07

Collect Fiddler Crabs from Stormu 2.
6 crabs in eight sample Areas.

830 2B - FC01 } Segment #4

900 2B - FC02

910 2B - FC03 } Segment #3

930 2B - FC04

940 2B - FC05 } Segment #2

955 2B - FC06

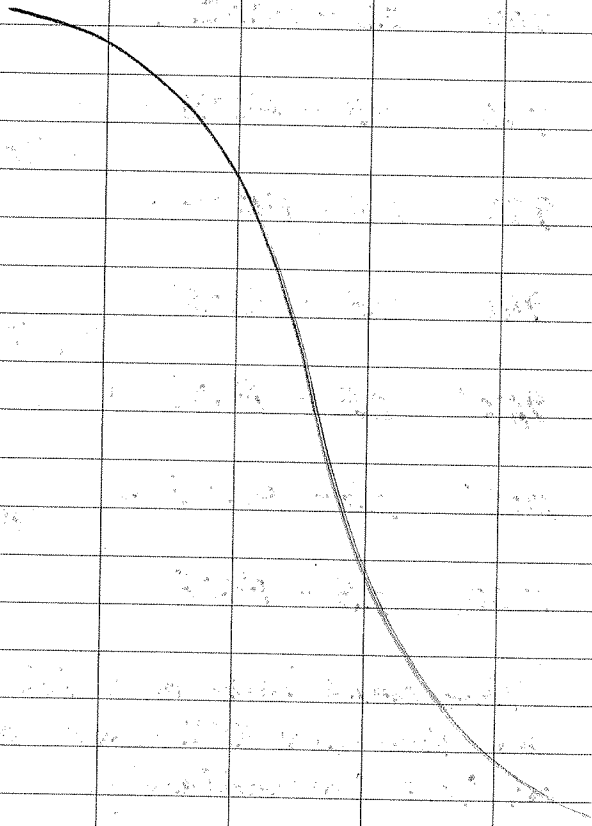
1005 2B - FC07 } Segment #1

1020 2B - FC08

Take crabs back to Public Works
and rinse with DI water and put
on ice immediately.

34

Use dingy boat to collect
Sea grass and open water
sediment.



35

5/22/07

1300

2B-OW-01

32.39°C
58.78 mS/cm
39.03 Sal
7.25 DO
8.18 pH

1330

2B-OW-02

Dip & MSD
collected
on sediment

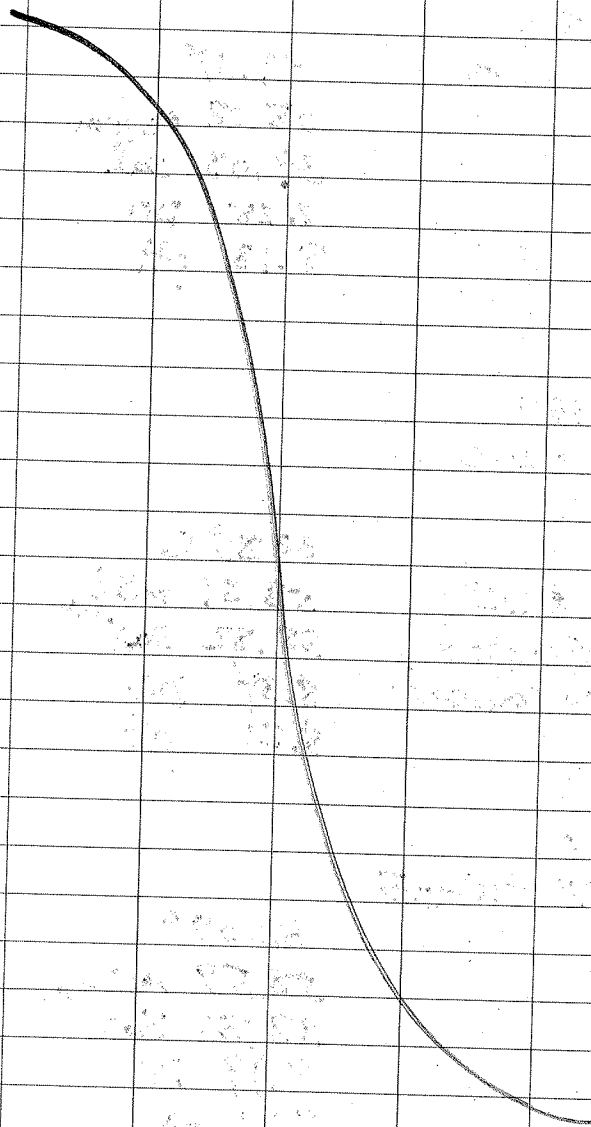
32.86°C
58.51 mS/cm
38.82 Sal
8.34 DO
8.21 pH

1400

2B-OW-03

33.09°C
58.59 mS/cm
38.86 Sal
8.99 DO
8.20 pH

(36)



(37)

5/23/07

After freezing sea grass and fiddler crabs. The samples were packed and shipped via Fedex to STL-savannah.

Also shipped 5/23/07 were QA/QC samples including Equipment rinsates and field blanks. In addition to open water ~~sediment~~ sediment samples.

Spoon

2B-ER01

Bucket Ager

2B-ER02

Aluminum Pie Pan 2B-ER03

Field Blanks

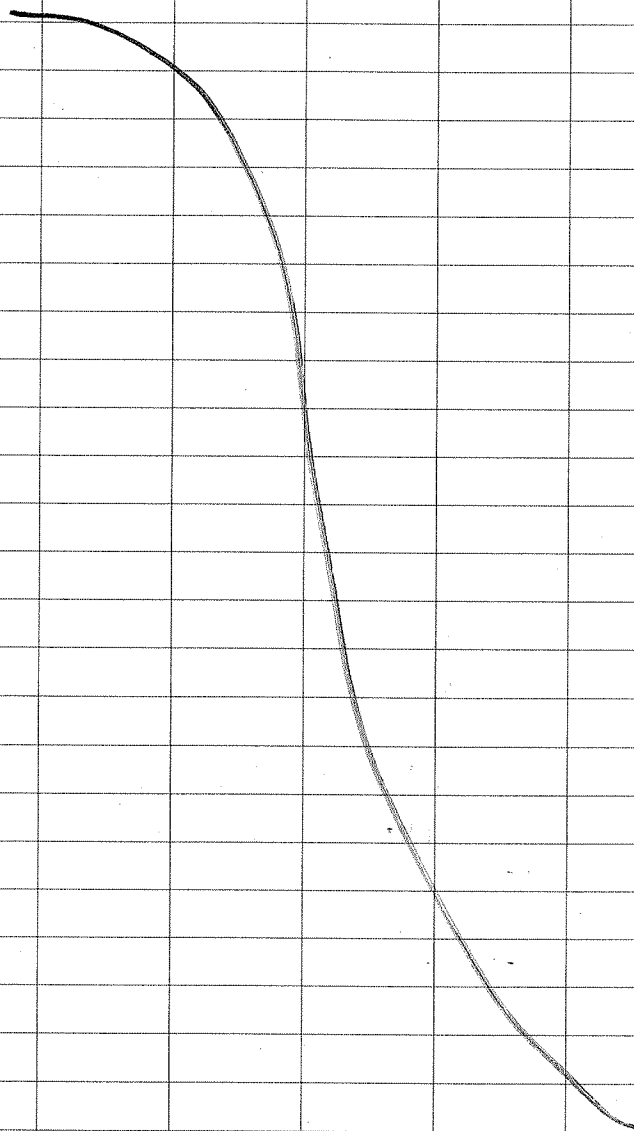
Labs Grade DI

2B-FB01

Base Potable Water

2B-FB02

(38)



(39)

5/24/07

Received results on metals
quick turn results and collect
the following samples for
28 Day TOX Testings.

Sediments

2B REF EWSD 01
2B REF EWSD 02

2B EWSD 04
2B EWSD 09
2B EWSD 12
2B EWSD 15
2B EWSD 16
2B EWSD 18
2B EWSD 20
2B EWSD 24

(40)

Soils

2SS03 2B SS04
 2B SS05
 2B SB 04-01

06101 2B SS10

SS11 2B SS13
 2B SS14

2SS05 2B SS31
 2B SS33
 2B SS34

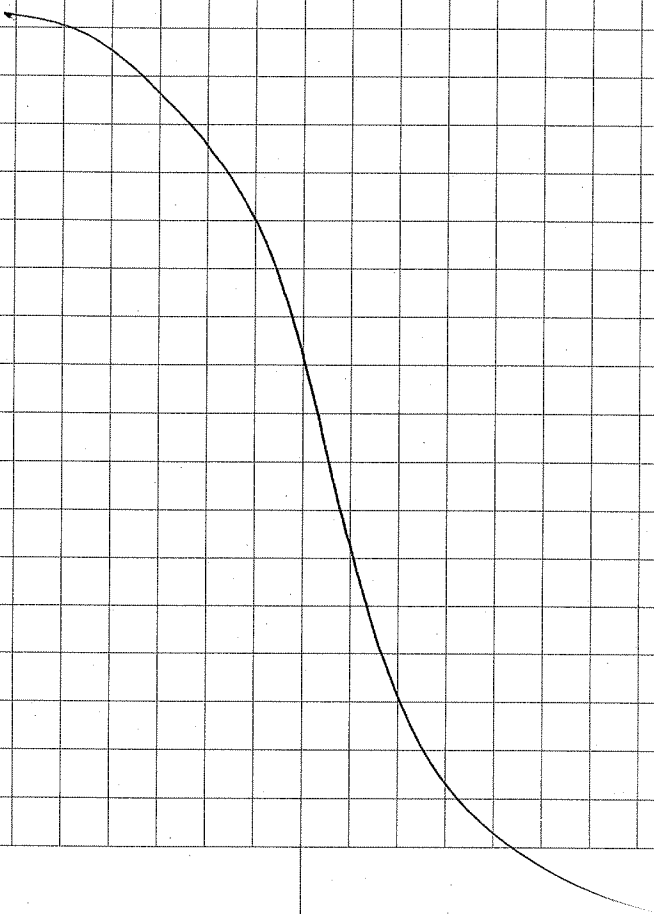
2SB03 2B SS41
 2B SS44

2SB01 2B SS49

(40)

Soil Reference Samples

2B - REF - SB01 - 01
 2B - REF - SS04
 2B - REF - SS05



APPENDIX D
CHAIN-OF-CUSTODY FORMS

VERIFICATION OF THE FIELD SAMPLING DESIGN

Serial Number 71192

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENTSTL FedEx AIRBILL No.:
0480 3122 5244STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location

Phone:
Fax:

SWMU 45 SITE VERIFICATION

PROJECT REFERENCE SWMU 45 Field Verification		PROJECT NO. CTO-108 FI.SV.45	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 1	OF 3
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...) Aroclor 1260 (8082) As, Cd, Cu, Pb, Se, Zn (6020), Hg (7471A)	TOC (9060) Grain Size (ASTM D422)	PRESERVATIVE								STANDARD REPORT DELIVERY	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX 412-375-3995												DATE DUE 28 Day TAT	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com													EXPEDITED REPORT DELIVERY (SURCHARGE)	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108		COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill													DATE DUE	
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE	TIME															
9/20/06	0746	45B-SD01V			X		1	1	1	1						
	0809	45B-SD02V			X		1	1	1	1						
	0818	45B-SD03V			X		1	1	1	1						
	0827	45B-SD04V			X		1	1	1	1						
	0834	45B-SD05V			X		1	1	1	1						
	0838	45B-SD06V			X		1	1	1	1						
	0909	REF1-SD01V			X		1	1	1	1						
	0921	REF1-SD02V			X		1	1	1	1						
	0929	REF1-SD03V			X		1	1	1	1						
	0936	REF1-SD04V			X		1	1	1	1						
	0946	REF1-SD05V			X		1	1	1	1						
	0953	REF1-SD06V			X		1	1	1	1						
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	
[Signature]		9/19/06	0700	[Signature]		9/21/06	1500	[Signature]				[Signature]				
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	
[Signature]		9/19/06	0700	[Signature]				[Signature]				[Signature]				
RECEIVED FOR LAB (SIGNATURE)		DATE	TIME	CUSTODY INTACT		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS						
[Signature]		09/20/06	0848	YES		10		600-20478								

Page 77 of 79

TEMP. 1.0 2.0
2.0

Serial Number 71194

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENTSTL FedEx Airbill No:
8480 3122 5244STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location

SWMU 45 SITE VERIFICATION

Phone:
Fax:

PROJECT REFERENCE SWMU 45 Field Verification		PROJECT NO. CTO-108 FI.SV.45	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 2	OF 3	
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...) Aroclor 1260 (8082) As, Cd, Cu, Pb, Se, Zn (6020), Hg (7471A)	TOC (9060) Grain Size (ASTM D422)											STANDARD REPORT DELIVERY DATE DUE 28 DAY TAT	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX 412-375-3995													EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com														NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																	
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																	
SAMPLE		SAMPLE IDENTIFICATION												NUMBER OF CONTAINERS SUBMITTED		REMARKS	
DATE	TIME																
9/20/06	1638	REF2-SD01V			X			1	1	1	1						
	1647	REF2-SD02V			X			1	1	1	1						
	1700	REF2-SD03V			X			1	1	1	1						
	1709	REF2-SD04V			X			1	1	1	1						
	1709	REF2-SD04VD			X			1	1								
	1709	REF2-SD04VMS/MSD			X			1	1								
	1727	REF2-SD05V			X			1	1	1	1						
	1734	REF2-SD06V			X			1	1	1	1						
9/21/06	0838	REF3-SD01V			X			1	1	1	1						
	0852	REF3-SD02V			X			1	1	1	1						
	0838	REF3-SD03VD			X			1	1								
		REF3-SD04V															
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME		
[Signature]		9/19/06	0700	[Signature]		9/21/06	1500										
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME		
[Signature]		9/19/06	0700														
RECEIVED FOR: (SIGNATURE)		DATE	TIME	CUSTODY INTACT		CUSTODY SEAL		AN H		LABORATORY REMARKS							
[Signature]		9/20/06	0848	YES <input type="radio"/>		YES <input type="radio"/>		478									

Page 78 of 79

Serial Number 76892

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENTSTL® FedEx AirBill No.:
8480 3122 5244STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

Alternate Laboratory Name/Location

SWMU 45 SITE VERIFICATION

Phone:
Fax:

PROJECT REFERENCE SWMU 45 Field Verification	PROJECT NO. CTO-108 FI.SV.45	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 3	OF 3
STL (LAB) PROJECT MANAGER Kathy Smith	P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...) Aroclor 1260 (8082) As, Cd, Cu, Pb, Se, Zn (6020), Hg (7471A) TOC (9060) Grain Size (ASTM D422)											STANDARD REPORT DELIVERY DATE DUE 28 DAY/MT	
CLIENT (SITE) PM Mark Kimes	CLIENT PHONE 412-337-7465	CLIENT FAX 412-375-3995												EXPEDITED REPORT DELIVERY (SURCHARGE)	
CLIENT NAME Baker Environmental, Inc.	CLIENT E-MAIL mkimes@mbakercorp.com													DATE DUE	
CLIENT ADDRESS: 100 Airside Drive, Moon Township, PA 15108 COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill														NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	

SAMPLE		SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	NUMBER OF CONTAINERS SUBMITTED										REMARKS
DATE	TIME																	
		REF3 SD05V																
		REF3 SD06V																
		REF3 SD06VD																
9/20/06	1630	45B-ER01V	X					2	1									
9/20/06	1408	45B-FB01V	X					2	1									

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
				9/21/06	1500			
RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
	9/19/06	0700						

RECEIVED BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
		09/20/06	0848	YES		680-20978	

Serial Number 94892

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD


**SEVERN
TRENT****STL**FEDEx AIRBILL No.:
8471 8519 9537STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165☐ Alternate Laboratory Name/LocationPhone:
Fax:

PROJECT REFERENCE SWMUs 1 and 2 SV		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR		MATRIX TYPE	REQUIRED ANALYSIS										PAGE 2	OF 8
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.		COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...)	LL-PAHs	App IX Organo-chlorine Pesticides	App IX Metals	Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, & 4,4'-DDT	Cu, Pb, Hg, Zn	Ammonia and Sulfide	TOC	Grain Size	pH	STANDARD REPORT DELIVERY DATE DUE 28 day TAT	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX			EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE											
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com		NUMBER OF COOLERS SUBMITTED PER SHIPMENT:													
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108		COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill		REMARKS													
SAMPLE		SAMPLE IDENTIFICATION				NUMBER OF CONTAINERS SUBMITTED											
DATE	TIME																
2/27/07	1103	2V-SS01				G	S										
	1113	2V-SS02				G	S										
	1120	2V-SS03				G	S										
	1407	2V-SS04				G	S										
	1403	2V-SS05				G	S										
	1400	2V-SS06				G	S										
	1158	2V-SB01				G	S										
	1147	2V-SB02				G	S										
	1213	2V-SB03				G	S										
	1439	2V-SB04				G	S										
	1445	2V-SB05				G	S										
	1455	2V-SB06				G	S										
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME		
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME		
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS										

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL 8471 8519 9537

 **STL Savannah**
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

○ Alternate Laboratory Name/Location

Phone:
Fax:

PROJECT REFERENCE SWMUs 1 and 2 SV		PROJECT NO. CTO-108		PROJECT LOCATION (STATE) PR		MATRIX TYPE		REQUIRED ANALYSIS										PAGE 3		OF 8	
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER		CONTRACT NO.		COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...) LL-PAHs App IX Organo-chlorine Pesticides APPX Metals Sb, Cd, Cu, Pb, Hg, Sn, Zn 4,4'-DDD,4,4'-DDE, & 4,4'-DDT Cu, Pb, Hg, Zn Ammonia and Sulfide TOC Grain Size PH												STANDARD REPORT DELIVERY DATE DUE 28 day TAT			
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465		CLIENT FAX														EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE			
CLIENT NAME Baker		CLIENT E-MAIL mkimes@mbakercorp.com																			
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																					
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																NUMBER OF COOLERS SUBMITTED PER SHIPMENT:					
SAMPLE		SAMPLE IDENTIFICATION				NUMBER OF CONTAINERS SUBMITTED										REMARKS					
DATE	TIME																				
2/28/07	1525	2V-EWSD01				G	S										✓	1	✓		
	1529	2V-EWSD02				G	S										✓	1	✓		
	1534	2V-EWSD03				G	S										✓	1	✓		
	1540	2V-EWSD04				G	S										✓	1	✓		
	1547	2V-EWSD05				G	S										✓	1	✓		
	1553	2V-EWSD06				G	S										✓	1	✓		
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME										
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME										
LABORATORY USE ONLY																					
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES NO		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS											

Serial Number 94894


ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165☐ Alternate Laboratory Name/LocationPhone:
Fax:**SEVERN
TRENT**STL *FedEx AIRBILL No.: 8471 8519 9537*

PROJECT REFERENCE SWMUs 1 and 2 SV		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 4	OF 9			
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...) LL-PAHs App IX Organo-chlorine Pesticides App IX Metals Sb, Cd, Cu, Pb, Hg, Sn, Zn 4,4'-DDT, 4,4'-DDE, & 4,4'-DDT Cu, Pb, Hg, Zn Ammonia and Sulfide TOC Grain Size PH											STANDARD REPORT DELIVERY <input checked="" type="radio"/>				
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX												DATE DUE 28 day TAT				
CLIENT NAME Baker		CLIENT E-MAIL mkimes@mbakercorp.com													EXPEDITED REPORT DELIVERY (SURCHARGE) <input type="radio"/>				
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108															DATE DUE _____				
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill					PRESERVATIVE										NUMBER OF COOLERS SUBMITTED PER SHIPMENT:				
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS				
DATE	TIME																		
2/28/07	0752	REF-SS01			G	S				✓	✓	✓				✓	✓	✓	
	0752	REF-SS01D			G	S				✓	✓	✓							
	0752	REF-SS01MS/MSD			G	S				✓	✓	✓							
	0801	REF-SS02			G	S				✓	✓	✓				✓	✓	✓	
	0815	REF-SS03			G	S							✓	✓		✓	✓	✓	
	0815	REF-SS03D			G	S							✓	✓					
	0823	REF-SS04			G	S							✓	✓		✓	✓	✓	
	0930	REF-SS05			G	S				✓	✓	✓				✓	✓	✓	
	0940	REF-SS06			G	S				✓	✓	✓				✓	✓	✓	
	1002	REF-SS07			G	S							✓	✓		✓	✓	✓	
	1016	REF-SS08			G	S							✓	✓		✓	✓	✓	
	1141	REF-SS09			G	S				✓	✓	✓				✓	✓	✓	
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME				
<i>Mark Kimes</i>		2/27/07	0615	<i>Mark Kimes</i>		3/1/07	1500												
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME				
<i>Mark Kimes</i>		2/27/07	0615																
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS									
<i>KL</i>		3/2/07	0927	YES <input type="radio"/> NO <input type="radio"/>				680-24740											

Serial Number 42345

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

 **STL Savannah**
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

☐ Alternate Laboratory Name/Location

Phone:
Fax:

SEVERN
TRENT

STL *FedEx AIRBILL No:*
8471 8519 9537

PROJECT REFERENCE SWMUs 1 and 2 SV		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 5	OF 8
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...)	LL-PAHs	App IX Organo-chlorine Pesticides	App IX Metals	Sb, Cd, Cu, Pb, Hg, Sn, Zn	4,4'-DDD, 4,4'-DDE, & 4,4'-DDT	Cu, Pb, Hg, Zn	Ammonia and Sulfide	TOC	Grain Size	pH	STANDARD REPORT DELIVERY DATE DUE 28 day TAT	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX												EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE	
CLIENT NAME Baker		CLIENT E-MAIL mkimes@mbakercorp.com													NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108															REMARKS	
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill				NUMBER OF CONTAINERS SUBMITTED												
SAMPLE DATE		SAMPLE IDENTIFICATION														
TIME																
2/28/07	1202	REF-SS010		G	S											
	1217	REF-SS011		G	S											
	1233	REF-SS012		G	S											
	0845	REF-SB01		G	S											
	0845	REF-SB01D		G	S											
	0845	REF-SB01MS/MSD		G	S											
	0855	REF-SB02		G	S											
	0900	REF-SB03		G	S											
	0904	REF-SB04		G	S											
		REF-SB05 <i>ONEK</i>														
	0944	REF-SB06		G	S											
	1006	REF-SB07		S	S											
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	
<i>Mark E. Kimes</i>		2/27/07	0615	<i>Mark E. Kimes</i>		3/1/07	1500									
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	
<i>Mark E. Kimes</i>		2/27/07	0615													
LABORATORY USE ONLY																
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS						
<i>KH</i>		3/2/07	0927					600-24740								


ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL

FED EX AIRBILL No.:

8471 8519 9537

 **STL Savannah**
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

☐ Alternate Laboratory Name/Location

Phone:
Fax:

PROJECT REFERENCE SWMUs 1 and 2 SV		PROJECT NO. CTO-108		PROJECT LOCATION (STATE) PR		MATRIX TYPE		REQUIRED ANALYSIS										PAGE 6		OF 8									
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER		CONTRACT NO.		COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...)		LL-PAHs		App IX Organo-chlorine Pesticides		AppIX Metals		Sb, Cd, Cu, Pb, Hg, Sn, Zn		4,4'-DDD, 4,4'-DDE, & 4,4'-DDT		Cu, Pb, Hg, Zn		Ammonia and Sulfide		TOC		Grain Size		pH		STANDARD REPORT DELIVERY DATE DUE 28 day TAT	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465		CLIENT FAX																								EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE	
CLIENT NAME Baker		CLIENT E-MAIL mkimes@mbakercorp.com																										NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																													
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																													
SAMPLE			SAMPLE IDENTIFICATION						NUMBER OF CONTAINERS SUBMITTED										REMARKS										
DATE	TIME																												
2/28/07	1020		REF-SB08																										
	1145		REF-SB09																										
	1206		REF-SB010																										
	1221		REF-SB011																										
	1237		REF-SB012																										
RELINQUISHED BY: (SIGNATURE)			DATE	TIME	RELINQUISHED BY: (SIGNATURE)			DATE	TIME	RELINQUISHED BY: (SIGNATURE)			DATE	TIME															
RECEIVED BY: (SIGNATURE)			DATE	TIME	RECEIVED BY: (SIGNATURE)			DATE	TIME	RECEIVED BY: (SIGNATURE)			DATE	TIME															
LABORATORY USE ONLY			LABORATORY USE ONLY												LABORATORY REMARKS														
RECEIVED FOR LABORATORY BY: (SIGNATURE)			DATE	TIME	CUSTODY INTACT			CUSTODY SEAL NO.			STL SAVANNAH LOG NO.			LABORATORY REMARKS															
KL			3/2/07	0927	YES <input type="radio"/> NO <input type="radio"/>			100-24740																					

Serial Number 71188

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL

FEDEX AIRBILL NO:

847185199537

STL Savannah

5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com

Phone: (912) 354-7858

Fax: (912) 352-0165

○ Alternate Laboratory Name/Location

Phone:

Fax:

PROJECT REFERENCE SWMUs 1 and 2 SV		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 7	OF 8			
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...) LL-PAHs App IX Organo-chlorine Pesticides App IX Metals Sb, Cd, Cu, Pb, Hg, Sn, Zn 4,4'-DDD, 4,4'-DDE, & 4,4'-DDT Cu, Pb, Hg, Zn Ammonia and Sulfide TOC Grain Size pH											STANDARD REPORT DELIVERY DATE DUE 28 day TAT				
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX												EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE				
CLIENT NAME Baker		CLIENT E-MAIL mkimes@mbakercorp.com													NUMBER OF COOLERS SUBMITTED PER SHIPMENT:				
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																			
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																			
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS				
DATE	TIME																		
3/1/07	0752	REF-EWSD01			G	S								✓	✓	✓	✓	✓	
	0752	REF-EWSD01D			G	S								✓					
	0752	REF-EWSD01MS/MSD			G	S								✓					
	0804	REF-EWSD02			G	S								✓	✓	✓	✓	✓	
	0811	REF-EWSD03			G	S								✓	✓	✓	✓	✓	
	0818	REF-EWSD04			G	S								✓	✓	✓	✓	✓	
	0826	REF-EWSD05			G	S								✓	✓	✓	✓	✓	
	0839	REF-EWSD06			G	S								✓	✓	✓	✓	✓	
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME				
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME				

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT YES ○ NO ○	CUSTODY SEAL NO.	STL SAVANNAH LOG NO. 680-24740	LABORATORY REMARKS
KL	3/2/07	0920				

 **STL Savannah**
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

SWNW 142
SITE VER.

☐ Alternate Laboratory Name/Location

Phone: _____
Fax: _____

SEVERN
TRENT

STL

FEDEX AIRBILL No. 8471 8519 9537

PROJECT REFERENCE SWMUs 1 and 2 SV		PROJECT NO. CTO-108		PROJECT LOCATION (STATE) PR		MATRIX TYPE		REQUIRED ANALYSIS										PAGE 8 OF 8							
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER		CONTRACT NO.		COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...) LL-PAHs App IX Organo-chlorine Pesticides App IX Metals Sb, Cd, Cu, Pb, Hg, Sn, Zn 4,4'-DDD, 4,4'-DDE, & 4,4'-DDT Cu, Pb, Hg, Zn Ammonia and Sulfide TOC Grain Size pH		STANDARD REPORT DELIVERY DATE DUE 28 day TAT										EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE							
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465		CLIENT FAX				NUMBER OF COOLERS SUBMITTED PER SHIPMENT:										REMARKS							
CLIENT NAME Baker		CLIENT E-MAIL mkimes@mbakercorp.com																							
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																									
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																									
SAMPLE DATE TIME		SAMPLE IDENTIFICATION				NUMBER OF CONTAINERS SUBMITTED										REMARKS									
2/27/07 1610		1V-ER01				2 2 1																			
2/28/07 1630		2V-ER01				2 2 1																			
3/1/07 1605		REF-ER01				1																			
2/27/07 1620		1V-FB01				2 2 1																			
RELINQUISHED BY: (SIGNATURE) [Signature]														DATE 3/1/07		TIME 1500		RELINQUISHED BY: (SIGNATURE) [Signature]				DATE		TIME	
RECEIVED BY: (SIGNATURE) [Signature]														DATE 2/27/07		TIME 0615		RECEIVED BY: (SIGNATURE) [Signature]				DATE		TIME	
LABORATORY USE ONLY																									
RECEIVED FOR LABORATORY BY: (SIGNATURE) [Signature]		DATE 3/2/07		TIME 0927		CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>		CUSTODY SEAL NO.		STL SAVANNAH LOG NO. 680-24740		LABORATORY REMARKS													

BERA FIELD INVESTIGATION

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL

FED EX
AIRBILL #
8327 0628 5709
0402STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com

Phone: (912) 354-7858

Fax: (912) 352-0165

2B-010

Alternate Laboratory Name/Location

STL-Seattle, 5755 8th St. East
Tacoma, WA 98424

Phone: (253) 922-2310

Fax:

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 1	OF 4	
STL (LAB) PROJECT MANAGER Katie Downie		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...) Total Sb, Cu, Pb, Hg, Zn												STANDARD REPORT DELIVERY <input type="radio"/>	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX													DATE DUE _____	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com														EXPEDITED REPORT DELIVERY (SURCHARGE) <input checked="" type="radio"/>	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108		COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill														DATE DUE 5/24 8am EST	
DATE 5/18/07		TIME 1310		SAMPLE IDENTIFICATION 2B-SS39		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE 5/18/07		TIME 1315		SAMPLE IDENTIFICATION 2B-SS40		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE 5/18/07		TIME 1610		SAMPLE IDENTIFICATION 2B-SS41		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE 5/18/07		TIME 1615		SAMPLE IDENTIFICATION 2B-SS42		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE 5/18/07		TIME 1620		SAMPLE IDENTIFICATION 2B-SS43		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE 5/18/07		TIME 1625		SAMPLE IDENTIFICATION 2B-SS44		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE 5/18/07		TIME 1625		SAMPLE IDENTIFICATION 2B-SS44D		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE 5/18/07		TIME 815		SAMPLE IDENTIFICATION 2B-SS24		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE 5/18/07		TIME 815		SAMPLE IDENTIFICATION 2B-SS24D		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE 5/18/07		TIME 815		SAMPLE IDENTIFICATION 2B-SS24 MS/MSD		NUMBER OF CONTAINERS SUBMITTED										REMARKS	
RELINQUISHED BY: (SIGNATURE) <i>Joe Burman</i>		DATE 5/18/07	TIME 630	RELINQUISHED BY: (SIGNATURE) <i>Joe Burman</i>		DATE 5/24/07	TIME 1500	RELINQUISHED BY: (SIGNATURE) <i>Kharles</i>		DATE 5/24/07	TIME 0930	RELINQUISHED BY: (SIGNATURE)		DATE	TIME		
RECEIVED BY: (SIGNATURE) <i>Joe Burman</i>		DATE 5/18/07	TIME 630	RECEIVED BY: (SIGNATURE) <i>Kharles</i>		DATE 5/24/07	TIME 0930	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME		
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS										

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENTSTL FED EX Airbill No.
8327 0628 5709 0402STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com

Phone: (912) 354-7858

Fax: (912) 352-0165 2B-011

Alternate Laboratory Name/Location

STL-Seattle, 5755 8th St. East
Tacoma, WA 98424

Phone: (253) 922-2310

Fax:

PROJECT REFERENCE SWMU 2 STEP 6	PROJECT NO. CTO-108	PROJECT LOCATION (STATE/PR)	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 2	OF 4
STL (LAB) PROJECT MANAGER Kathy Smith Katie Downie	P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...) Total Sb, Cu, Pb, Hg, Zn											STANDARD REPORT DELIVERY <input type="radio"/>	
CLIENT (SITE) PM Mark Kimes	CLIENT PHONE 412-337-7465	CLIENT FAX												DATE DUE _____	
CLIENT NAME Baker Environmental, Inc.	CLIENT E-MAIL mkimes@mbakercorp.com													EXPEDITED REPORT DELIVERY (SURCHARGE) <input checked="" type="radio"/>	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108														DATE DUE 5/24 8am EST	
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill													NUMBER OF COOLERS SUBMITTED PER SHIPMENT:		

SAMPLE		SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...)	NUMBER OF CONTAINERS SUBMITTED										REMARKS
DATE	TIME																	
5/18/07	1630	2B-SS45	G	X			1											
	1645	2B-SS46	G	X			1											
	1650	2B-SS47	G	X			1											
	1655	2B-SS48	G	X			1											
	1700	2B-SS49	G	X			1											
	1705	2B-SS50	G	X			1											
		2B-SS51 e JHB																
		2B-SS52 e JHB																
		2B-SS53 e JHB																
		2B-SS54 e JHB																
		2B-SS54D e JHB																
		2B-SS55 e JHB																

RELINQUISHED BY: (SIGNATURE) <i>Joe Berman</i>	DATE 5/18/07	TIME 630	RELINQUISHED BY: (SIGNATURE) <i>Joe Berman</i>	DATE 5/21/07	TIME 1500	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
RECEIVED BY: (SIGNATURE) <i>Joe Berman</i>	DATE 5/18/07	TIME 630	RECEIVED BY: (SIGNATURE) <i>Khesley</i>	DATE 5/21/07	TIME 0930	RECEIVED BY: (SIGNATURE)	DATE	TIME

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
--	------	------	---	------------------	-------------------------	--------------------

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENTSTL FED EX Airbill No.
8327 0628 5709 0402STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404Website: www.stlinc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

2B-012

Alternate Laboratory Name/Location
STL-Seattle, 5755 8th St. East
Tacoma, WA 98424Phone: (253) 922-2310
Fax:

PROJECT REFERENCE SWMU 2 STEP 6	PROJECT NO. CTO-108	PROJECT LOCATION (STATE) R	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 3	OF 4		
STL (LAB) PROJECT MANAGER Kathy Smith Katie Downie	P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...) Total Sb, Cu, Pb, Hg, Zn											STANDARD REPORT DELIVERY <input type="radio"/>	DATE DUE _____	
CLIENT (SITE) PM Mark Kimes	CLIENT PHONE 412-337-7465	CLIENT FAX														EXPEDITED REPORT DELIVERY <input checked="" type="radio"/> (SURCHARGE)	DATE DUE 5/24 8am EST
CLIENT NAME Baker Environmental, Inc.	CLIENT E-MAIL mkimes@mbakercorp.com															NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																	
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																	

SAMPLE		SAMPLE IDENTIFICATION	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR	NONAQUEOUS LIQUID (OIL, SOLVENT,...) Total Sb, Cu, Pb, Hg, Zn	NUMBER OF CONTAINERS SUBMITTED										REMARKS
DATE	TIME														
5/20/07		2B-REF-SB01-01	G	X	1										
		2B-REF-SB02-01	G	X	1										
		2B-REF-SB03-01	G	X	1										
		2B-REF-SB04-01	G	X	1										
		2B-REF-SB04-01D	G	X	1										
		2B-REF-SB05-01	G	X	1										
		2B-REF-SB06-01	G	X	1										
5/18/07	1335	2B-SB01-01	G	X	1										
5/18/07	1350	2B-SB02-01	G	X	1										
		2B-SB03-01 JHB													
5/18/07	1405	2B-SB04-01	G	X	1										
5/18/07	1405	2B-SB04-01D	G	X	1										

RELINQUISHED BY: (SIGNATURE) Joe Burana	DATE 5/18/07	TIME 630	RELINQUISHED BY: (SIGNATURE) Joe Burana	DATE 5/21/07	TIME 1500	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
RECEIVED BY: (SIGNATURE) Joe Burana	DATE 5/18/07	TIME 630	RECEIVED BY: (SIGNATURE) K. H. Jones	DATE 5/22/07	TIME 0930	RECEIVED BY: (SIGNATURE)	DATE	TIME

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
--	------	------	---	------------------	-------------------------	--------------------

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL

FED EX Airbill No.

8327 0628 5709 0402

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com

Phone: (912) 354-7858

Fax: (912) 352-0165

2B-013

Alternate Laboratory Name/Location

STL-Seattle, 5755 8th St. East
Tacoma, WA 98424

Phone: (253) 922-2310

Fax:

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 4	OF 4	
STL (LAB) PROJECT MANAGER Kathy Smith Katie Downie		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...)	Total Sb, Cu, Pb, Hg, Zn											STANDARD REPORT DELIVERY DATE DUE _____	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX													EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE 5/24 8am EST	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com														NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																	
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																	
SAMPLE		SAMPLE IDENTIFICATION				NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE	TIME																
5/18/07	1405	2B-SB04-01MS/MSD		G	X												
		2B-SB05-01 JHB															
5/18/07	1520	2B-SB06-01		G	X												
5/18/07	1525	2B-SB07-01		G	X												
5/18/07	1535	2B-SB08-01		G	X												
5/18/07	1550	2B-SB09-01		G	X												
5/18/07	1605	2B-SB10-01		G	X												
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME		
<i>[Signature]</i>				<i>[Signature]</i>		5/24/07	1500	<i>[Signature]</i>				<i>[Signature]</i>					
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME		
<i>[Signature]</i>		5/18/07	630	<i>[Signature]</i>		5/22/07	0930	<i>[Signature]</i>				<i>[Signature]</i>					
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS							
				YES <input type="radio"/> NO <input type="radio"/>													

Serial Number 42361 5970

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENTSTL FED EX Airbill No.
8480 3122 4330 0402STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

2B-001

Alternate Laboratory Name/Location

Phone:
Fax:

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 5	OF 9
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...) Total Sb, Cu, Pb, Hg, Zn											STANDARD REPORT DELIVERY DATE DUE _____	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX												EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE <u>5/24 8am EST</u>	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com													NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE	TIME															
5/20/07	1315	2B-REF-SS01			G	X		1								
	1340	2B-REF-SS02			G	X		1								
	1320	2B-REF-SS03			G	X		1								
	1330	2B-REF-SS04			G	X		1								
	1330	2B-REF-SS04D			G	X		1								
	1330	2B-REF-SS04MS/MSD			G	X		1								
	1400	2B-REF-SS05			G	X		1								
	1410	2B-REF-SS06			G	X		1								
		2B-SS01 e														
		2B-SS02 e one K														
		2B-SS03 e														
		2B-SS04 e														
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	
Joe B...		5/18/07	630	Joe B...		5/21/07	1500	Joe B...		5/22/07	0930	Joe B...				
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	
Joe B...		5/18/07	630	Joe B...		5/22/07	0930	Joe B...				Joe B...				
LABORATORY USE ONLY																
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS						
KL		5/22/07	0933					640-26880								

TEMP.: 5.7

Page 13 of 244

STL

Page 59 of 87

STL

Page 60 of 87

STL

Page 70 of 87
3

STL

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

2B-001

☐ Alternate Laboratory Name/Location

Phone:
Fax:

SEVERN
TRENT

STL FED EX Airbill No.
8480 3122 4330 0402

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 1	OF 4	
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...) Total Sb, Cu, Pb, Hg, Zn												STANDARD REPORT DELIVERY <input type="radio"/>	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX														DATE DUE _____
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com															EXPEDITED REPORT DELIVERY (SURCHARGE) <input checked="" type="radio"/>
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																	DATE DUE 5/24 8am EST
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill					NUMBER OF COOLERS SUBMITTED PER SHIPMENT:										REMARKS		
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS		
DATE	TIME																
5/20/07	1315	2B-REF-SS01			G	X										not rec'd in 23	
	1340	2B-REF-SS02			G	X										Savannah. 20	
	1320	2B-REF-SS03			G	X										all samples	
	1330	2B-REF-SS04			G	X										on loc# 42361	
	1330	2B-REF-SS04D			G	X										will be analyzed	
	1330	2B-REF-SS04MS/MSD			G	X										at STL Seattle	
	1400	2B-REF-SS05			G	X										KS	
	1410	2B-REF-SS06			G	X										5/22/07	
		2B-SS01 e														TEMP.: 5.7	
		2B-SS02 e ONEK															
		2B-SS03 e															
		2B-SS04 e															
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME		
Joe B...		5/18/07	630	Joe B...		5/21/07	1500										
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME		
Joe B...		5/18/07	630														
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS										
KL		5/22/07	0933			650-26380											


ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL

FED EX Airbill No.

8480 3122 4330 0402

 **STL Savannah**
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com

Phone: (912) 354-7858

Fax: (912) 352-0165

2B-002

○ Alternate Laboratory Name/Location

Phone:


Fax:

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108		PROJECT LOCATION (STATE)PR		MATRIX TYPE		REQUIRED ANALYSIS										PAGE 2		OF 4	
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER		CONTRACT NO.		COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...)		Total As, Cd, Cu, Pb, Hg, Se, Zn Total Cu, Pb, Hg, Zn TOC Grain Size										STANDARD REPORT DELIVERY		DATE DUE	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465		CLIENT FAX														EXPEDITED REPORT DELIVERY (SURCHARGE)		DATE DUE	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com																			
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108								PRESERVATIVE										NUMBER OF COOLERS SUBMITTED PER SHIPMENT:		DATE DUE	
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																					
SAMPLE DATE TIME		SAMPLE IDENTIFICATION						NUMBER OF CONTAINERS SUBMITTED										REMARKS			
5/20/07 950		2B-REF-EWSD02				G X															
1010		2B-REF-EWSD03				G X															
1020		2B-REF-EWSD04				G X															
1020		2B-REF-EWSD04D				G X															
1020		2B-REF-EWSD04MS/MSD				G X															
1045		2B-REF-EWSD05				G X															
1105		2B-REF-EWSD06				G X															
5/19/07 730		2B-EWSD01				G X															
750		2B-EWSD02				G X															
810		2B-EWSD03				G X															
836		2B-EWSD04				G X															
830		2B-EWSD04D				G X															
RELINQUISHED BY: (SIGNATURE)		DATE		TIME		RELINQUISHED BY: (SIGNATURE)		DATE		TIME		RELINQUISHED BY: (SIGNATURE)		DATE		TIME					
[Signature]		5/18/07		630		[Signature]		5/21/07		1500		[Signature]									
RECEIVED BY: (SIGNATURE)		DATE		TIME		RECEIVED BY: (SIGNATURE)		DATE		TIME		RECEIVED BY: (SIGNATURE)		DATE		TIME					
[Signature]		5/18/07		630		[Signature]						[Signature]									
LABORATORY USE ONLY																					
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE		TIME		CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS									
KL		5/22/07		0933						680-26880											

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL FED EX Airbill No. 8480 3122 4330 0402

 **STL Savannah**
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com

Phone: (912) 354-7858

Fax: (912) 352-0165 2B-003

○ Alternate Laboratory Name/Location

Phone:

Fax:

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108		PROJECT LOCATION (STATE)PR		MATRIX TYPE		REQUIRED ANALYSIS										PAGE 3		4 OF	
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER		CONTRACT NO.		COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...) <i>Total As, Cd, Cu, Pb, Hg, Se, Zn</i> <i>Total Cu, Pb, Hg, Zn</i> <i>Grain Size</i>		STANDARD REPORT DELIVERY DATE DUE EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE <i>5/24 8am EST</i> NUMBER OF COOLERS SUBMITTED PER SHIPMENT:													
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465		CLIENT FAX																	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com																			
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																					
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill						REMARKS															
SAMPLE DATE TIME		SAMPLE IDENTIFICATION						NUMBER OF CONTAINERS SUBMITTED													
5/19/07 830		2B-EWSD04MS/MSD				G X		1													
850		2B-EWSD05				G X		1													
910		2B-EWSD06				G X		1													
930		2B-EWSD07				G X		1													
950		2B-EWSD08				G X		1													
1020		2B-EWSD09				G X		1													
1040		2B-EWSD10				G X		1													
1055		2B-EWSD11				G X		1													
1120		2B-EWSD12				G X		1													
1335		2B-EWSD13				G X		1													
1325		2B-EWSD14				G X		1													
1325		2B-EWSD14D				G X		1													
RELINQUISHED BY: (SIGNATURE) <i>Joe Benner</i>		DATE 5/21/07		TIME 1508		RELINQUISHED BY: (SIGNATURE) <i>Joe Benner</i>		DATE 5/21/07		TIME 1508		RELINQUISHED BY: (SIGNATURE)		DATE		TIME					
RECEIVED BY: (SIGNATURE) <i>Joe Benner</i>		DATE 5/18/07		TIME 630		RECEIVED BY: (SIGNATURE) <i>Joe Benner</i>		DATE 5/18/07		TIME 630		RECEIVED BY: (SIGNATURE)		DATE		TIME					
LABORATORY USE ONLY																					
RECEIVED FOR LABORATORY BY: (SIGNATURE) <i>KL</i>		DATE 5/22/07		TIME 0933		CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>		CUSTODY SEAL NO.		STL SAVANNAH LOG NO. 680-26880		LABORATORY REMARKS									

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

2B-004

☐ Alternate Laboratory Name/Location


Phone:
Fax:

SEVERN
TRENT

STL FED EX Airbill No.
8480 3122 4330 0402

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 4	4 th	
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR	NONAQUEOUS LIQUID (OIL, SOLVENT, ...) Total As, Cd, Cu, Pb, Hg, Se, Zn Total Cu, Pb, Hg, Zn TOC Grain Size											STANDARD REPORT DELIVERY <input type="radio"/>	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX													DATE DUE	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com														EXPEDITED REPORT DELIVERY (SURCHARGE) <input type="radio"/>	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																DATE DUE 5/24 8am EST	
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill					PRESERVATIVE										NUMBER OF COOLERS SUBMITTED PER SHIPMENT:		
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS		
DATE	TIME																
5/19/07	1315	2B-EWSD15			G	X											
	1300	2B-EWSD16			G	X											
		2B-EWSD17															JHB
	1350	2B-EWSD18			G	X											
	1410	2B-EWSD19			G	X											
	1425	2B-EWSD20			G	X											
	1440	2B-EWSD21			G	X											
	1360	2B-EWSD22			G	X											
	1520	2B-EWSD23			G	X											
	1545	2B-EWSD24			G	X											TEMP: 5.7
5/20/07	930	2B-REF-EWSD01			G	X											
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME		
Joe Bunnara				Joe Bunnara		5/21/07	1500										
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME		
Joe Bunnara		5/18/07	630														
LABORATORY USE ONLY																	
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS										
K		5/22/07	0932			680-26580											

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

 **STL Savannah**
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

2B-014

☐ Alternate Laboratory Name/Location

Phone:
Fax:

SEVERN
TRENT

STL FED EX Airbill No. 8480 31 22 4340 0402

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108		PROJECT LOCATION (STATE)PR		MATRIX TYPE		REQUIRED ANALYSIS										PAGE 1		OF 3					
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER		CONTRACT NO.		COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...)		Total Sb, Cu, Pb, Hg, Zn		Total As, Cd, Cu, Pb, Hg, Se, Zn		Total Sb, As, Cd, Cu, Pb, Hg, Se, Zn										STANDARD REPORT DELIVERY		DATE DUE _____	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465		CLIENT FAX																		EXPEDITED REPORT DELIVERY (SURCHARGE)		DATE DUE _____	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com																						NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																									
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																									
SAMPLE		SAMPLE IDENTIFICATION																				REMARKS			
DATE	TIME																								
5/21/07	935	2B-ER01																				Spoon			
5/20/07	8805	2B-ER02																				Hand Auger			
5/21/07	940	2B-ER03																				PAN			
		2B-ER04 9405																							
5/21/07	930	2B-FB01																				LAB			
5/21/07	945	2B-FB02																				TAP			
RELINQUISHED BY: (SIGNATURE)		DATE		TIME		RELINQUISHED BY: (SIGNATURE)		DATE		TIME		RELINQUISHED BY: (SIGNATURE)		DATE		TIME									
EMPTY CONTAINER		5-18-07		630		[Signature]		5/23/07		1400															
RECEIVED BY: (SIGNATURE)		DATE		TIME		RECEIVED BY: (SIGNATURE)		DATE		TIME		RECEIVED BY: (SIGNATURE)		DATE		TIME									
[Signature]		5-18-07		630		[Signature]																			
LABORATORY USE ONLY																									
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE		TIME		CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS													
[Signature]		5-24-07		0921						680-210980															

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL

FED EX Airbill No.

8480 3122 4390 0402

STL Savannah

5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com

Phone: (912) 354-7858

Fax: (912) 352-0165

2B-015

○ Alternate Laboratory Name/Location

Phone:

Fax:

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 2	OF 3	
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR	NONAQUEOUS LIQUID (OIL, SOLVENT, ...)	Total As, Cd, Cu, Pb, Hg, Se, Zn	Total Cu, Pb, Hg, Zn	TOC	Grain Size							STANDARD REPORT DELIVERY <input checked="" type="radio"/>	DATE DUE _____
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX													EXPEDITED REPORT DELIVERY (SURCHARGE) <input type="radio"/>	DATE DUE _____
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com														NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108		COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill														REMARKS	
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED												
DATE	TIME																
5/22/07	1300	2B-OWSD01			G	X											
	1330	2B-OWSD02			G	X											
	1330	2B-OWSD02D			G	X											
	1330	2B-OWSD02MS/MSD			G	X											
	1400	2B-OWSD03			G	X											
	1300	2B-SG01-AG			G	X											
	1300	2B-SG001-WP			G	X											
	1330	2B-SG02-AG			G	X											
	1330	2B-SG02-WP			G	X											
	1400	2B-SG03-AG			G	X											
	1400	2B-SG03-WP			G	X											
		2B REF EWSD01 e msk.															
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)	
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)	
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS							
Brown Humberg		5-24-07	0901					680-26980									

Serial Number 52893

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL

FED EX Airbill No.

8480 3122 4340 0402

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com

Phone: (912) 354-7858

Fax: (912) 352-0165

2B-016

○ Alternate Laboratory Name/Location

Phone:

Fax:

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 3	OF 3		
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMI-SOLID AIR NON-AQUEOUS LIQUID (OIL, SOLVENT, ...)	Percent Lipids	Total Pb, Hg											STANDARD REPORT DELIVERY DATE DUE _____	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX														EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE _____	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com															NUMBER OF COOLERS SUBMITTED PER SHIPMENT: 12	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																		
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill					one sample container for each set													
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS			
DATE	TIME																	
5/21/07	1247	2B-REF-FC01			G	X		X	X									
	1315	2B-REF-FC02			G	X		X	X									
	1339	2B-REF-FC03			G	X		X	X									
	1415	2B-REF-FC04			G	X		X	X									
5/22/07	830	2B-FC01			G	X		X	X									
	900	2B-FC02			G	X		X	X									
	910	2B-FC03			G	X		X	X									
	930	2B-FC04			G	X		X	X									
	940	2B-FC05			G	X		X	X									
	955	2B-FC06			G	X		X	X									
	1005	2B-FC07			G	X		X	X									
	1020	2B-FC08			G	X		X	X									
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME			
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME			

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT YES ○ NO ○	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS
Brian Mulford	5-24-07	0921			680-26980	

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD



STL

FEDEX
Air Bill #
8327 0628 5422 0402

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

2B-005

Alternate Laboratory Name/Location 301
STL-Pittsburgh, Alpha Dr.
Pittsburgh, PA 15238

Phone: (412) 963-7058
Fax: (412) 963-2468

PROJECT REFERENCE SMMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE		REQUIRED ANALYSIS										PAGE 1	OF 5			
STL (LAB) PROJECT MANAGER Veronica Bortot		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT, ...)	Total Sb, Cu, Pb, Hg, Zn											STANDARD REPORT DELIVERY <input type="radio"/>
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE (412) 337-7465	CLIENT FAX																	DATE DUE _____
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com																		EXPEDITED REPORT DELIVERY (SURCHARGE) <input checked="" type="radio"/>
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																				DATE DUE 5/24 8am EST
COMPANY CONTRACTING THIS WORK (if applicable) CH2M HILL																NUMBER OF COOLERS SUBMITTED PER SHIPMENT:				
SAMPLE		SAMPLE IDENTIFICATION														REMARKS				
DATE	TIME																			
5/18/07	1330	2B-SS01		G	X															
	1345	2B-SS02		G	X															
	1415	2B-SS03		G	X															
	1400	2B-SS04		G	X															
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME					
<i>Joe Bunn</i>		5/18/07	630	<i>Joe Bunn</i>		5/21/07	1500	<i>Joe Bunn</i>				<i>Joe Bunn</i>								
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME					
<i>Joe Bunn</i>		5/18/07	630	<i>Joe Bunn</i>				<i>Joe Bunn</i>				<i>Joe Bunn</i>								
LABORATORY USE ONLY																				
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input checked="" type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS													
<i>Joe Bunn</i>		05-22-07	1000																	

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

2B-006

Alternate Laboratory Name/Location

STL-Pittsburgh, 301 Alpha Drive
Pittsburgh, PA 15238

Phone: (412) 963-7058
Fax: (412) 963-2468

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 2	OF 5		
STL (LAB) PROJECT MANAGER Kathy Smith Veronica Bortot		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...) Total Sb, Cu, Pb, Hg, Zn												STANDARD REPORT DELIVERY <input type="radio"/>	DATE DUE _____	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX														EXPEDITED REPORT DELIVERY (SURCHARGE) <input checked="" type="radio"/>	DATE DUE 5/24 8am EST
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com															NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108																		
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																		
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS			
DATE	TIME																	
5/18/07	1400	2B-SS04D			G	X												
	1400	2B-SS04MS/MSD			G	X												
	1430	2B-SS05			G	X												
	1515	2B-SS06			G	X												
	1520	2B-SS07			G	X												
	1530	2B-SS08			G	X												
	1545	2B-SS09			G	X												
	1600	2B-SS10			G	X												
	710	2B-SS11			G	X												
	715	2B-SS12			G	X												
	720	2B-SS13			G	X												
	725	2B-SS14			G	X												
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME			
<i>Joe Burman</i>		5/18/07	630	<i>Joe Burman</i>		5/18/07	1500	<i>Joe Burman</i>		5/18/07	1500	<i>Joe Burman</i>		5/18/07	1500			
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME			
<i>Joe Burman</i>		5/18/07	630	<i>Joe Burman</i>		5/18/07	630	<i>Joe Burman</i>		5/18/07	630	<i>Joe Burman</i>		5/18/07	630			
LABORATORY USE ONLY																		
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input checked="" type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS											
<i>Joe Burman</i>		05-22-07	1000															

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

2B-007

Alternate Laboratory Name/Location

STL-Pittsburgh, 301 Alpha Drive
Pittsburgh, PA 15238

Phone: (412) 963-7058
Fax: (412) 963-2468

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE/PR)	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 3	OF 5
STL (LAB) PROJECT MANAGER Kathy Smith Veronica Bortot		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...) Total Sb, Cu, Pb, Hg, Zn	PRESERVATIVE										STANDARD REPORT DELIVERY DATE DUE _____	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 12-337-7465	CLIENT FAX												EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE 5/24 8am EST	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com													NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108		COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill													REMARKS	
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE	TIME															
5/18/07	725	2B-SS14D			G	X										
	725	2B-SS14MS/MSD			G	X										
	730	2B-SS15			G	X										
	735	2B-SS16			G	X										
	740	2B-SS17			G	X										
	745	2B-SS18			G	X										
	750	2B-SS19			G	X										
	755	2B-SS20			G	X										
	800	2B-SS21			G	X										
	805	2B-SS22			G	X										
	810	2B-SS23			G	X										
		2B-SS24 JHB			G	X										JHB
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	
		5		Joe Burawa		5/21/07	1500									
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	
Joe Burawa		5/18/07	630													
LABORATORY USE ONLY																
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input checked="" type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS									
Paul Park		05-12-07	1000													

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

2B-008

Alternate Laboratory Name/Location

STL-Pittsburgh, 301 Alpha Drive
Pittsburgh, PA 15238

Phone: (412) 963-7058
Fax: (412) 963-2468

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 4	OF 5
STL (LAB) PROJECT MANAGER Kathy Smith Veronica Bortol		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...) Total Sb, Cu, Pb, Hg, Zn											STANDARD REPORT DELIVERY <input type="radio"/>	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 12-337-7465	CLIENT FAX												DATE DUE _____	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com													EXPEDITED REPORT DELIVERY (SURCHARGE) <input checked="" type="radio"/>	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108															DATE DUE 5/24 8am EST	
COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill														NUMBER OF COOLERS SUBMITTED PER SHIPMENT:		
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS	
DATE	TIME															
		2B-SS24D													JHB	
		2B-SS24MS/MSB													JHB	
5/18/07	820	2B-SS25			G	X		1								
	825	2B-SS26			G	X		1								
	830	2B-SS27			G	X		1								
	845	2B-SS28			G	X		1								
	835	2B-SS29			G	X		1								
	840	2B-SS30			G	X		1								
	1725	2B-SS31			G	X		1								
	1230	2B-SS32			G	X		1								
	1235	2B-SS33			G	X		1								
	1240	2B-SS34			G	X		1								
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	
<i>Joe Burman</i>		5/18/07	630	<i>Joe Burman</i>		5/21/07	1500									
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	
<i>Joe Burman</i>		5/18/07	630													
LABORATORY USE ONLY																
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input checked="" type="radio"/> NO <input type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS									
<i>Joe Burman</i>		05-22-07	1000	<i>none</i>												

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD



STL FED EX Airbill No.

8327 0628 5422 0402

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stlinc.com

Phone: (912) 354-7858

Fax: (912) 352-0165

2B-009

Alternate Laboratory Name/Location

STL-Pittsburgh, 301 Alpha Drive
Pittsburgh, PA 15238

Phone: (412) 963-7058

Fax: (412) 963-2468

PROJECT REFERENCE SWMU 2 STEP 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE)	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 5	OF 5
STL (LAB) PROJECT MANAGER Rachy Smith Veronica Borby		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT, ...) Total Sb, Cu, Pb, Hg, Zn	PRESERVATIVE										STANDARD REPORT DELIVERY DATE DUE _____	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX												EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE 5/24 8am EST	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com													NUMBER OF COOLERS SUBMITTED PER SHIPMENT:	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108		COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill													REMARKS	
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED											
DATE	TIME															
5/18/07	1240	2B-SS34D			G	X		1								
	1245	2B-SS35			G	X		1								
	1250	2B-SS36			G	X		1								
	1255	2B-SS37			G	X		1								
	1300	2B-SS38			G	X		1								
		2B-SS39 JHB														
		2B-SS40 JHB														
		2B-SS41 JHB														
		2B-SS42 JHB														
		2B-SS43 JHB														
		2B-SS44 JHB														
		2B-SS44D JHB														
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	
<i>Joe Burman</i>		5/18/07	630	<i>Joe Burman</i>		5/24/07	1500	<i>Joe Burman</i>				<i>Joe Burman</i>				
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	
<i>Joe Burman</i>		5/18/07	630	<i>Joe Burman</i>				<i>Joe Burman</i>				<i>Joe Burman</i>				
LABORATORY USE ONLY																
RECEIVED FOR LABORATORY BY: (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input checked="" type="radio"/>	CUSTODY SEAL NO.	STL SAVANNAH LOG NO.	LABORATORY REMARKS									
<i>Joe Burman</i>		05-22-07	1000													

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

SEVERN
TRENT

STL

FEDEx INTL AIRBILL No:
8471 8519 9504STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com

Phone: (912) 354-7858

Fax: (912) 352-0165 453ERA-02


☐ Alternate Laboratory Name/Location

Phone:

Fax:

PROJECT REFERENCE SWMU 45 Step 6		PROJECT NO. CTO-108	PROJECT LOCATION (STATE) PR	MATRIX TYPE	REQUIRED ANALYSIS										PAGE 1	OF 3	
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER	CONTRACT NO.	COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...) Aroclor 1260 (24 hr TAT) As, Cd, Cu, Hg, Sb As, Cd, Hg, Se TOC Grain Size pH Ammonia As, Cd, Cu, Hg, Se, Sb	PRESERVATION											STANDARD REPORT DELIVERY <input checked="" type="radio"/>	
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465	CLIENT FAX													DATE DUE 28 day TAT	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com														EXPEDITED REPORT DELIVERY (SURCHARGE) <input type="radio"/>	
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108		COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill														DATE DUE	
SAMPLE		SAMPLE IDENTIFICATION			NUMBER OF CONTAINERS SUBMITTED										REMARKS		
DATE	TIME																
1/30/07	0900	SWMU 45 45B-VEG-SED01			G	X					X	X	1				
1/30/07	0900	45B-VEG-SED01D			G	X					X	X					
1/30/07	0900	45B-VEG-SED01MS/MSD			G	X					X	X					
1/30/07	1100	45B-VEG-SED02			G	X					X	X	1				
1/30/07	1000	45B-VEG-SED03			G	X					X	X	1				
		Reference Area 2															
1/31/07	0830	REF2-VEG-SED01			G	X					X	X	1				
1/31/07	0920	REF2-VEG-SED02			G	X					X	X	1				
1/31/07	1000	REF2-VEG-SED03			G	X					X	X	1				
RELINQUISHED BY: (SIGNATURE) EMPTY CONTAINERS		DATE	TIME	RELINQUISHED BY: (SIGNATURE) Mark E. Kimes		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME		
RECEIVED BY: (SIGNATURE) Mark E. Kimes		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME		
RECEIVED FOR LABORATORY BY: (SIGNATURE) X		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>		CUSTODY SEAL NO.		STL SAVANNAH LOG NO. 680-23902		LABORATORY REMARKS							

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

 **STL Savannah**
5102 LaRoche Avenue
Savannah, GA 31404

Phone: (912) 354-7858

Fax: (912) 352-0165 453ERA-02

○ Alternate Laboratory Name/Location

Fax:


SEVERN
TRENT

STL

FedEx Int'l Airbill No.:
8471 8519 9504

[illegible]

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

 **STL Savannah**
5102 LaRoche Avenue
Savannah, GA 31404

Website: www.stl-inc.com
Phone: (912) 354-7858
Fax: (912) 352-0165

45 BEPA-04

○ Alternate Laboratory Name/Location

Phone:
Fax:

SEVERN
TRENT

STL

FDEx INT'L AIRBILL No.:

8471 85199526

PROJECT REFERENCE SWMU 45 Step 6		PROJECT NO. CTO-108		PROJECT LOCATION (STATE) PR		MATRIX TYPE		REQUIRED ANALYSIS										PAGE 1		OF 1	
STL (LAB) PROJECT MANAGER Kathy Smith		P.O. NUMBER		CONTRACT NO.		COMPOSITE (C) OR GRAB (G) INDICATE AQUEOUS (WATER) SOLID OR SEMISOLID AIR NONAQUEOUS LIQUID (OIL, SOLVENT,...) Aroclor 1260 (24 hr TAT) As, Cd, Cu, Hg, Sb As, Cd, Hg, Se TOC Grain Size pH Ammonia As, Cd, Cu, Hg, Se, Sb		STANDARD REPORT DELIVERY DATE DUE 28 day TAT EXPEDITED REPORT DELIVERY (SURCHARGE) DATE DUE NUMBER OF COOLERS SUBMITTED PER SHIPMENT: 2													
CLIENT (SITE) PM Mark Kimes		CLIENT PHONE 412-337-7465		CLIENT FAX																	
CLIENT NAME Baker Environmental, Inc.		CLIENT E-MAIL mkimes@mbakercorp.com																			
CLIENT ADDRESS 100 Airside Drive, Moon Township, PA 15108 COMPANY CONTRACTING THIS WORK (if applicable) CH2M Hill																					
SAMPLE		SAMPLE IDENTIFICATION						NUMBER OF CONTAINERS SUBMITTED										REMARKS			
DATE	TIME																				
		Reference Area 2 (cont.)																			
1/31/07	1000	REF2-VEG-WB03																			
1/31/07	1000	REF2-VEG-AB03																			
1/31/07	0920	REF2-VEG-WB02																			
1/31/07	0920	REF2-VEG-AB02																			
1/31/07	0830	REF2-VEG-WB01																			
1/31/07	0830	REF2-VEG-AB01																			
TEMP. 0.4																					
RELINQUISHED BY: (SIGNATURE) EMPTY CONTAINERS		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RELINQUISHED BY: (SIGNATURE)		DATE	TIME										
RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME	RECEIVED BY: (SIGNATURE)		DATE	TIME										
LABORATORY USE ONLY																					
RECEIVED FOR LABORATORY (SIGNATURE)		DATE	TIME	CUSTODY INTACT YES <input type="radio"/> NO <input type="radio"/>		CUSTODY SEAL NO.		STL SAVANNAH LOG NO.		LABORATORY REMARKS											
		020207	1158					600-23974													

APPENDIX E
EISENIA FETIDA, LEPTOCHEIRUS PLUMULOSUS, AND
NEANTHES ARENACEODENTATA TOXICITY TEST REPORT

Fort Environmental Laboratories, Inc.

Environmental Laboratory Services/Consulting

July 27, 2007

John Malinowski
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

Re: Toxicity testing on soils and sediments conducted under Navy Clean III Contract Task Orders (CTO) 0108 for sample site Langley Drive Disposal (SWMU 2).

Dear John,

The following report documents the results of a soil toxicity screen with an earthworm test species and estuarine sediment toxicity screens with marine amphipod and polychaete species. Sample handling documents and raw data are attached to this report.

INTRODUCTION

Fort Environmental Laboratories, Inc. (FEL) was contracted by CH2M Hill to perform a whole soil toxicity test with earthworm species *Eisenia fetida* and whole sediment toxicity tests with amphipod species *Leptocheirus plumulosus* and polychaete species *Neanthes arenaceodentata*, to evaluate the effect of contaminants found at Solid Waste Management Unit (SWMU) 2 (Langley Drive Disposal Site), Naval Activity Puerto Rico, Ceiba, Puerto Rico. Baker Environmental, Inc. (Baker), also contracted by CH2M Hill, was responsible for sample collection and shipment to FEL, and review of this report. The major endpoints for the soil toxicity study were mortality, growth, and reproduction. Bioaccumulation of soil contaminants in earthworm tissue collected by FEL at toxicity test conclusion were performed and presented by TestAmerica Laboratories (Savannah, GA) in a separate report. The major endpoints for the sediment toxicity studies were mortality, growth, and reproduction (*L. plumulosus*) and mortality and growth (*N. arenaceodentata*). The methods used and the results and conclusions derived from the toxicity tests are presented in this report. The chains-of-custody and supporting raw data (mortality, growth, reproduction, statistical data, and soil chemistry) are attached.

MATERIALS AND METHODS

APPARATUS (*E. FETIDA*)

- Temperature controlled (22°C, \pm 3°C) chemical free room,
- Test vessels (500-1000 mL glass jars with ventilated lids), and
- Dissecting scope (10X or 15X power).

APPARATUS (*L. PLUMULOSUS*)

- Temperature controlled (25°C, \pm 3°C) chemical free room with controlled photoperiod,
- Lab oven,
- Filtering apparatus (with filter paper) and vacuum pump,
- Dissecting scope (10X or 15X power),
- Test vessels (1-L glass jars), and
- Water reservoir (120 L plastic drum or carboy) for static renewal.

APPARATUS (*N. ARENACEODENTATA*)

- Temperature controlled (25°C, \pm 3°C) chemical free room with controlled photoperiod,
- Lab oven,
- Filtering apparatus (with filter paper) and vacuum pump,
- Dissecting scope (10X or 15X power),
- Test vessels (100 mm x 20 mm Petri dishes), and
- Water reservoir (120 L plastic drum or carboy) for static renewal.

TEST SUBSTANCES

Fifteen soil samples (12 test sites and 3 reference sites) and 10 estuarine sediment samples (8 test sites and 2 reference sites) were collected at SWMU 2.

Sample Handling and Tracking

Test site samples (soils and sediments) were collected on May 18 and 19, 2007 and reference site samples were collected on May 20, 2007. All samples were shipped on May 24, 2007 via commercial carrier and received at FEL on May 25, 2007. Upon arrival, samples were inventoried using the attached chains of custody. The chains-of-custody were then signed and dated and the samples were assigned appropriate tracking numbers and recorded in the sample check-in logbook. Tracking numbers were also recorded on the individual sample bottles. Samples were stored at 4°C throughout the testing and holding periods.

LABORATORY CONTROL SOIL AND HYDRATION WATER

Laboratory prepared soil consisting of an organic top soil and peat moss mixture was used as the laboratory control in the soil toxicity test. Laboratory-prepared water, referred to as dechlorinated (DeCl₂) water, was used when needed to hydrate the soil samples. DeCl₂ water was prepared by passing tap water through 3 filters; a 10" pre-treatment filter (5 μ m) to remove solids, a 3.6 cf activated virgin carbon treatment filter to remove chlorine, ammonia, and higher molecular weight organics, and a 5 μ m post-filter to remove any carbon particles from the carbon treatment phase.

LABORATORY CONTROL SEDIMENT AND OVERLYING WATER

Laboratory prepared water, referred to reconstituted seawater (RSW) water, was used as the overlying water with laboratory reference sediment as the laboratory negative control. RSW source water was prepared by adding Instant Ocean® (Aquarium Systems, Inc., Mentor, OH) to laboratory dechlorinated tap water to simulate seawater. The optimum salinity for the RSW was 30-35 ppt.

TEST SYSTEMS

Eisenia fetida (Manure or Red Worm)

E. fetida, commonly known as red or manure worm, is readily available in nature and is easily cultured in the laboratory. The red worm has a short life-cycle and its sensitivity makes it a good indicator of toxicity in several types test media including soil, sediment, and sludge. Sexually mature, fully clitellate adults were used at test initiation. *E. fetida* were purchased from Aquatic Research Organisms (ARO), Hampton, NH, and shipped next day delivery to FEL. Upon arrival at FEL, worms were sorted and chosen for testing. Worms were not fed during the 28-d assay. The worms were handled as little as possible to reduce stress to the organisms. Any worms injured or dropped while handling were discarded.

Leptocheirus plumulosus (Marine Amphipod)

Test species *L. plumulosus*, marine amphipod, is readily available in nature and is easily cultured in the laboratory. Neonatal organisms between 0.25 and 0.6 mm (< 48 h old) were used at test initiation (d 0). *L. plumulosus* were purchased from ARO (Hampton, NH) and shipped next day delivery to FEL. Upon arrival at FEL, amphipods were sorted and chosen for testing. Any injured amphipods were discarded. The amphipods were fed TetraFin® fish food 3 times per week after test renewal. Flakes were fed at 20 mg per test chamber on study d 0-13 and increased to 40 mg on d 14-28.

Neanthes arenaceodentata (Marine Polychaete Worm)

Test species, *N. arenaceodentata*, commonly known as marine polychaete worm, is readily available in nature and is easily cultured in the laboratory. *N. arenaceodentata* were purchased from Dr. Don Reish (Los Alamitos, CA) through ARO (Hampton, NH) and shipped next day delivery to FEL. Upon arrival at FEL, worms were sorted and chosen for testing. Worms were fed TetraFin® fish food every other day (on Monday-Wednesday-Friday) during the 20-d assay. The polychaete worms were handled as little as possible to reduce stress to the organisms. Any worms injured or dropped while handling were discarded.

STUDY DESIGN

28-d Soil Toxicity Test with *E. fetida*

The soil toxicity test with *Eisenia fetida* was performed in accordance with ASTM Standard E-1676-04 (*Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia fetida and the Enchytraeid Potworm Enchytraeus albidus*). Each treatment (site and reference soil samples) plus laboratory control consisted of 8 replicate 1 L glass jars containing 350 g of soil and 10 red worms. Jar lids were perforated for ventilation. Each soil sample was homogenized prior to test setup. The assay was conducted in a temperature controlled room ($22^{\circ}\text{C} \pm 3^{\circ}$) for 28 days under continuous light intensity ranging from 400-1,000 lux. Test specifications are outlined in Table 1.

Room temperature and light intensity were monitored and recorded daily. The pH, % moisture, and total organic carbon (TOC) of each soil sample was measured prior to test setup and at test takedown. The % moistures of 13 of the 15 soil samples were below the preferred limit (25%) and were hydrated using DeCl_2 water, after approval from Baker. Test jars were examined at test termination for survival (mortality), growth, and reproduction endpoints. Growth was expressed as the mean wet weight loss per surviving earthworm in each replicate at test termination. Reproduction was expressed as the mean number of juveniles plus cocoons per surviving earthworm in each replicate at test termination. After test takedown, test specimens were depurated for an additional 24 h and reweighed. The surviving worm specimens from each set of 8 replicates were composited for each soil treatment. Specimens were then frozen and shipped on dry ice to TestAmerica Laboratories for tissue residue analysis.

28-d Sediment Toxicity Test with *L. plumulosus*

The sediment toxicity screen with *L. plumulosus* was performed in accordance with EPA 600/R01-020 (*Methods for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-Associated Contaminants with the Amphipod, Leptocheirus plumulosus*). Each treatment (site and reference sediment samples) plus laboratory control consisted of 8 replicate 1 L glass jars containing 130 mL sediment, 675 mL of overlying RSW, and 20 healthy amphipod neonates. Sediments were homogenized prior to test setup. The assay was conducted in a temperature ($25^{\circ}\text{C} \pm 3^{\circ}$) and light controlled room for 28 days. The study received 16 h light: 8 h dark with a light intensity ranging from 500-1,000 lux. Approximately 400 mL of water was siphoned off from each test jar 3 times per week and replaced with fresh RSW prior to feeding. Test jars were examined at test termination for mortality, growth, and reproduction endpoints. Test jars were lidless and aeration was not required. Test specifications are outlined in Table 2.

Pore water was extracted from each sediment sample prior to test setup and again at test takedown for temperature, pH, salinity, ammonia-nitrogen ($\text{NH}_3\text{-N}$), and sulfide analyses. Also, 3 separate groups of 20 neonates were rinsed, placed on tared filter paper, oven-dried at 60°C for 24 h, and weighed to determine an initial dry weight per organism baseline. Water chemistry (temperature, pH, dissolved oxygen [DO], salinity, $\text{NH}_3\text{-N}$, and sulfide) was measured in the overlying water from one randomly selected replicate from each of the sediment treatments. Temperature and DO were measured daily. The pH and salinity were measured 3 times per

week. The $\text{NH}_3\text{-N}$ and sulfide were initially measured 3 times per week until consistency between analytical events could be determined; at which time test frequency was reduced to once per week, after approval from Baker.

At test conclusion (d 28), the amphipods from each test jar were counted to determine mortality (expressed as a percent), rinsed in deionized water, and weighed to determine growth. Rinsed amphipods from each replicate were placed on tared filter paper, oven-dried at 60°C for 24 h, and weighed. Growth was expressed as dry weight per organism per replicate. Reproduction was determined by counting the offspring from each replicate, expressed as number of offspring per surviving adult per replicate.

20-d Sediment Toxicity Test with *N. arenaceodentata*

The sediment toxicity screen with *N. arenaceodentata* was performed in accordance with ASTM Standard E-1562-00 (*Standard Guide for Conducting Acute, Chronic, and life-Cycle Aquatic Toxicity Tests with Polychaetous Annelids*). Each treatment (site and reference sediment samples) plus laboratory control consisted of 8 replicates of 10 worms, for a total of 880 worms. Due to possible cannibalism, each test worm was housed in its own individual test chamber (Petri dish) containing 8 mL of sediment and 40 mL of overlying RSW. Each sediment sample was homogenized prior to test setup. The assay was conducted in a temperature controlled room ($20^\circ\text{C} \pm 1^\circ\text{C}$) for 20 days. The photoperiod over the 20 days was 12 h light and 12 h dark, with a light intensity ranging from 500-1,000 lux during simulated daylight periods. Test specifications are outlined in Table 3.

Pore water was extracted from each sediment sample prior to test setup and again at test takedown for temperature, pH, salinity, $\text{NH}_3\text{-N}$, and sulfide measurements. A sampling of worms (12-14) were rinsed, placed on tared filter paper, oven-dried at 60°C for 24 h, and weighed to establish a baseline weight per worm on d 0. Due to the limited overlying water volume in each Petri dish, dummy test jars for each treatment using the same proportion (1:4 ratio) of sediment to overlying RSW were maintained in the exposure room for daily temperature and DO readings. Each test dish was renewed once per week by removing 10 mL of spent RSW and replacing with fresh RSW. The spent RSW was then composited by treatment and analyzed for pH, salinity, $\text{NH}_3\text{-N}$, and sulfide. Baker approved the reduction of $\text{NH}_3\text{-N}$ and sulfide analyses from 3 times per week to once per week.

At test conclusion, survival counts were made and mortality determined for each replicate, expressed as a percentage. Surviving worms were composited by replicate, rinsed with deionized water, and oven-dried at 60°C for 24 h and weighed to determine growth, expressed as mean dried weight per surviving worm per replicate.

DATA ANALYSIS

The percent mortality was calculated for each treatment. Percent growth was determined by dividing the mean weight data from the appropriate treatment by the corresponding data collected from the laboratory control and the reference samples. Percent reproduction was determined by dividing the mean reproduction data from each treatment by the corresponding

data collected from the laboratory control and the reference samples. Statistical calculations, including hypothesis testing (Kruskal-Wallis [KW] ANOVA on ranks with Dunn's Method [$P < 0.05$] for nonparametric data sets and ANOVA with Bonferroni t-test [$P < 0.05$] for parametric data sets) were performed using SigmaStat® 2.03 statistical software (SPSS® Inc., Chicago, IL). All statistical evaluations included comparison of test site data for each endpoint to each individual reference sample and laboratory control.

TEST RESULTS AND DISCUSSION

28-D SOIL TOXICITY TEST WITH *E. FETIDA*

Control

Results from the laboratory control are provided in Table 4. Mean lethality (1.3%) met the acceptability criteria established in ASTM E1676-04.

Reference Sediments

Comparison of the laboratory control results to the reference sediments is provided in Table 4. Mean mortality in each of the reference site samples was 0.0%. Mean weight loss ranged from 177.0% (2B-REF-SS05) to 301.3% (2B-REF-SS04). No reproduction was observed in the reference site samples. Both sub-lethal endpoints were reported as a percentage of the laboratory control. Mortality in the reference site samples was not found to be significantly different from the laboratory control (KW-ANOVA, Dunn's Method, $P < 0.05$). However, significantly increased weight loss (growth) and decreased reproduction compared to the laboratory control was observed (KW-ANOVA, Dunn's Method, $P < 0.05$ for mortality and reproduction; and ANOVA, Bonferroni's t-test, $P < 0.05$ for growth). Statistical differences in the frequency of mortality, growth, or reproduction were detected between the reference sites (KW-ANOVA, Dunn's Method, $P < 0.05$) are reported in Table 5.

Test Sites

Comparison of the laboratory control results to the test site soils is provided in Table 4. Comparison of test site and reference soils results to each respective reference sediment result, with statistical comparisons, is provided in Table 5. Sites 2B-SS04-01 and 2B-SS34 induced 100% and 98.5% mortality, respectively. Statistical differences between various target sites and each reference site were noted for each endpoint and varied based on the reference site chosen for comparison. For the sake of brevity and clarity, discussion of this data will be limited and readers are referred to Table 5 for a summary of the findings.

Conclusions

Overall, results from the 28-d static toxicity tests with *E. fetida* indicated that test sites 2B-SS04-1 and 2B-SS34 were markedly lethal compared to either the laboratory control or the reference soils. Varying positive and negative effects of the test site soils on growth and reproduction were found relative to either the laboratory control or the reference site samples.

28-D SEDIMENT TOXICITY TEST WITH *L. PLUMULOSUS*

Control

Results from the laboratory control are provided in Table 6. Mean lethality (3.1%) met the acceptability criteria established in EPA/R01-020.

Reference Sediments

Comparison of the laboratory control results to the reference sediments is provided in Table 6. Mean mortality in the both of the reference site samples were 6.3%. Mean growth (dry weight) and reproduction ranged from 99.1% (2B-REF-EWSD-01) to 120.8% (2B-REF-EWSD-02) and 110.3% and 154.1%, respectively. Both sub-lethal endpoints were reported as a percentage of the laboratory control. Mortality and reproduction in the reference site samples were not found to be significantly different from the laboratory control (KW-ANOVA, Dunn's Method, $P < 0.05$). However, significantly increased growth compared to the laboratory control was observed in reference sample 2B-REF-EWSD-02 (ANOVA, Bonferroni's t-test, $P < 0.05$). Statistical differences in the frequency of mortality, growth, or reproduction were detected between the reference sites (KW-ANOVA, Dunn's Method, $P < 0.05$) are reported in Table 7.

Test Sites

Comparison of the laboratory control results to the test site soils is provided in Table 6. Comparison of test site and reference soils results to each respective reference sediment result, with statistical comparisons, is provided in Table 7. Each of the test site samples induced mortality. However, only test sites 2B-EWSD-04 and 2B-EWSD-16 were not statistical different from the laboratory control (KW-ANOVA, Dunn's Method, $P < 0.05$). Statistical difference between the laboratory control or reference sites and the test site treatments were noted for growth and varied in terms of increased or decreased growth (ANOVA, Bonferroni's t-test, $P < 0.05$). No statistical differences in reproduction between the test sites and either the laboratory control or the reference sites were observed (KW-ANOVA, Dunn's Method, $P < 0.05$). For the sake of brevity and clarity, discussion of this data will be limited and readers are referred to Tables 6 and 7 for a summary of the findings.

Conclusions

Overall, results from the 28-d static toxicity tests with *L. plumulosus* indicated that the test sites were markedly lethal compared to either the laboratory control or the reference soils. Varying positive and negative effects of the test site soils on growth was found relative to either the laboratory control or the reference site samples. The target sites had no apparent effect on reproductive performance.

20-D SEDIMENT TOXICITY TEST WITH *N. ARENACEODENTATA*

Control

Results from the laboratory control are provided in Table 8. Mean lethality (17.5%) met the acceptability criteria established in ASTM E1562-00.

Reference Sediments

Comparison of the laboratory control results to the reference sediments is provided in Table 8. Mean mortality in the both of the reference site samples ranged from 26.3% (2B-REF-EWSD-01) to 47.5% (2B-REF-EWSD-02). Mean growth (weight) ranged from 170.4%% (2B-REF-EWSD-02) to 218.1% (2B-REF-EWSD-01), reported as a percentage of the laboratory control. Mortality (2B-REF-EWSD-02) and growth (2B-REF-EWSD-01) in the reference site samples were found to be significantly different from the laboratory control (ANOVA, Bonferroni's t-test, $P < 0.05$). No statistical differences in mortality or growth were observed between the two reference sites (ANOVA, Bonferroni's t-test, $P < 0.05$) (Table 9).

Test Sites

Comparison of the laboratory control results to the test site soils is provided in Table 8. Comparison of test site and reference soils results to each respective reference sediment result, with statistical comparisons, is provided in Table 9. Mortality in test sites 2B-EWSD-09 and 2B-EWSD-24 were statistical different from the laboratory control (ANOVA, Bonferroni's t-test, $P < 0.05$). Statistical difference between the laboratory control or reference sites and the test site treatments were noted for growth, such that growth was actually greater in the test site treatment (ANOVA, Bonferroni's t-test, $P < 0.05$). For the sake of brevity and clarity, discussion of this data will be limited and readers are referred to Tables 8 and 9 for a summary of the findings.

Conclusions

Overall, results from the 20-d static toxicity tests with *N. arenaceodentata* indicated that test site 2B-EWSD-09 was lethal compared to either the laboratory control or the reference sediment 2B-REF-EWSD-01, although mortality in test site 2B-EWSD-24 was significantly greater than the laboratory control. Reference site sample 2B-REF-EWSD-02 induced 47.5% mortality which complicated statistical comparison. Growth (dry weight) was increased in the test site samples. Since growth data are expressed as a percentage of control growth, the increased weight was most likely the result of increased food supply in the respective test site sediments.

If you have any questions concerning this report, please do not hesitate to contact us at 405-624-6771, or by e-mail at djfort@fortlabs.com or rrogers@fortlabs.com.

Sincerely,

A handwritten signature in black ink, appearing to read 'DJ Fort', with a stylized flourish at the end.

Douglas J. Fort, Ph.D.
President

Attachments

Table 1
Soil Toxicity Test Specifications with *E. fetida*

Test type	Fixed exposure system
Test species	<i>Eisenia fetida</i> (red worm)
Test initiation	Within 14 days from sample receipt
Species age (test setup)	Sexually mature adult with clitella
Feeding regime	Do not feed
Test duration	28 days
Test treatments	17 soils (including 3 reference sites)
Laboratory control	Laboratory reference soil
Replicates	8 per soil treatment
Number of test animals	10 per replicate (80 per treatment)
Soil volume	350 g per test jar
Test vessel	1 L glass jar with perforated lid
Light quality	Ambient laboratory
Light intensity	400 to 1000 lux
Photoperiod	Continuous light
Room temperature	22 ± 3°C
% moisture, pH, TOC	Days 0 and 28
Room temperature and light intensity	Daily
Survival counts	Day 28
Organism weights	Days 0 and 28
Hatchling counts (including cocoon contents)	Day 28
Test validation	≤ 20% mortality in control animals

Table 2
Sediment Toxicity Test Specifications with *L. plumulosus*

Test type	Static-renewal exposure system
Test species	<i>L. plumulosus</i> (marine amphipod)
Test initiation	Within 14 days from sample receipt
Species age (test setup)	< 48-h old neonates
Feeding regime	Day 0-13 20 mg; Day 14-28 40 mg TetraFin®/chamber
Renewal and feeding schedule	3 times/week (M-W-F)
Test duration	28 days
Test treatments	10 sediments (including 2 reference sites)
Laboratory control	Laboratory reference sediment
Replicates	8 per sediment treatment
Number of test organisms	20 per replicate (160 per treatment)
Sediment volume	130 mL per test jar
Overlying water	Synthetic seawater (ca. 30 ppt salinity)
Overlying water volume	675 mL per test jar
Test vessel	1 L glass jar
Light quality	Ambient laboratory
Light intensity	500 to 1000 lux
Photoperiod	16 h light:8 h dark
Room temperature	25 ± 3°C (28-d mean : 25 ± 2°C)
DO limit (aerate as needed)	≥ 3.6 mg/L (28-d mean: ≥4.4 mg/L)
Temperature and DO (overlying water)	Daily
pH, salinity, NH ₃ -N, and sulfide (overlying water)	Day 0, 3 times/week, and day 28
Temperature, pH, salinity, NH ₃ -N, and sulfide (pore water)	Days 0 and 28
Survival counts	Day 28
Organism weight	Days 0 and 28
Reproduction	Day 28
Test validation	≤ 20% mortality in control animals

Table 3
Sediment Toxicity Test Specifications with *N. arenaceodentata*

Test type	Static-renewal exposure system
Test species	<i>N. arenaceodentata</i> (polychaete worm)
Test initiation	Within 30 days from sample collection date
Species age (test setup)	1-3 months
Feeding regime	8 mg dry TetraFin®/worm every other day
Test duration	20 days
Test treatments	10 sediments (including 2 reference sites)
Laboratory control	Laboratory reference sediment
Replicates	8/sediment treatment
Number of test animals	1/dish – 10 /replicate – 80/treatment
Test vessel	100 mm x 20 mm Petri dish
Sediment volume	7.5 mL/dish
Overlying water volume	30 mL/dish
Control sediment	Marine culture sediment from ARO
Overlying water	Synthetic seawater (ca. 30 ppt salinity)
Light quality	Ambient laboratory
Light intensity	500 to 1000 lux
Photoperiod	12 h light:12 h dark
Overlying temperature	20 ± 1°C
DO limit (aeration not required)	≥ 3.6 mg/L
Temperature and DO (overlying water)	Daily (using 1 dummy sample/treatment)
pH, salinity, NH ₃ -N, and sulfide (overlying water)	Day 0, 3 times/week, day 20 on composite of replicates from each treatment
pH, salinity, NH ₃ -N, and sulfide (pore water)	Days 0 and 20
Survival counts	Daily
Organism weight	Days 0 and 20
Test validation	≤ 20% mortality in control animals

Table 4
Comparison of SWMU 2 Site and Reference Results and Hypothesis Testing to
Laboratory Control Results of Whole Soil Toxicity Test with *E. fetida*

Sample ID	Mean Mortality ¹ (%)	Endpoints Compared to Lab Control		Significantly Different from Lab Control		
		Weight Loss ² (%)	Reproduction ³ (%)	Mortality ⁴	Weight Loss ⁵	Reproduction ⁴
Lab Control	1.25	-	-	-	-	-
2B-REF-SS01-01	0.00	221.03	0.00	No	Yes (>)	Yes (<)
2B-REF-SS04	0.00	301.25	0.00	No	Yes (>)	Yes (<)
2B-REF-SS05	0.00	177.01	0.00	No	Yes (>)	Yes (<)
2B-SS04	2.50	174.15	0.00	No	Yes (>)	Yes (<)
2B-SS05	2.50	164.35	0.00	No	No	Yes (<)
2B-SS04-01	100.0	-	-	Yes (>)	-	-
2B-SS10	1.25	115.51	0.00	No	No	Yes (<)
2B-SS13	1.25	203.21	6.82	No	Yes (>)	Yes (<)
2B-SS14	0.00	106.77	6.82	No	No	Yes (<)
2B-SS31	2.50	315.51	103.41	No	Yes (>)	No
2B-SS33	1.25	110.52	0.00	No	No	Yes (<)
2B-SS34 ⁶	98.75	-	-	Yes (>)	-	-
2B-SS41	2.50	231.73	72.44	No	Yes (>)	No
2B-SS44	0.00	172.01	61.39	No	No	No
2B-SS49	3.75	281.64	6.82	No	Yes (>)	Yes (<)

¹ Mean mortality was calculated by averaging the percent mortality of the replicates from each treatment sample.

² Weight loss was calculated by dividing the mean weight loss (g) of each test site sample by the mean weight loss of the lab control, expressed as a percent.

³ Reproduction was calculated by dividing the mean reproduction count of each test site sample by the mean reproduction count of the lab control, expressed as a percent.

⁴ Hypothesis testing for mortality and reproduction was performed using Kruskal-Wallis ANOVA on ranks with Dunn's Method ($P < 0.05$) for nonparametric data. (<) denotes statistical differences that were significantly less than the lab control. (>) denotes statistical differences that were significantly greater than the lab control.

⁵ Hypothesis testing for weight loss was performed using one-way ANOVA with Bonferroni t-test ($P < 0.05$) for parametric data. (>) denotes statistical differences that were significantly greater than the lab control.

⁶ Sediment treatment 2B-SS34 had 1 specimen out of 80 survive until test termination. The sample size was too small to be conducive to hypothesis testing and was excluded from weight loss and reproduction statistical comparisons.

Table 5
Comparison of SWMU 2 Site and Reference Results and Hypothesis Testing to
Reference Results of Whole Soil Toxicity Test with *E. fetida*

Sample ID	Mean Mortality ¹ (%)	Growth Compared to References ²						Results Significantly Different From References ³								
		2B-REF01-01		2B-REF04		2B-REF05		2B-REF01-01			2B-REF04			2B-REF05		
		Wt Loss (%)	Repro (%)	Wt Loss (%)	Repro (%)	Wt Loss (%)	Repro (%)	Mortality	Wt Loss	Repro	Mortality	Wt Loss	Repro	Mortality	Wt Loss	Repro
2B-REF-SS01-01	0.00	-	-	73.37	0.00	124.87	0.00	-	-	-	No	Yes (<)	No	No	No	No
2B-REF-SS04	0.00	136.29	0.00	-	-	170.19	0.00	No	Yes (>)	No	-	-	-	No	Yes (>)	No
2B-REF-SS05	0.00	80.08	0.00	58.76	0.00	-	-	No	No	No	No	Yes (<)	No	-	-	-
2B-SS04	2.50	78.79	0.00	57.81	0.00	98.39	0.00	No	No	No	No	Yes (<)	No	No	No	No
2B-SS05	2.50	74.35	0.00	54.56	0.00	92.85	0.00	No	No	No	No	Yes (<)	No	No	No	No
2B-SS04-01	100.0	-	-	-	-	-	-	Yes (>)	-	-	Yes (>)	-	-	Yes (>)	-	-
2B-SS10	1.25	52.26	0.00	38.34	0.00	65.26	0.00	No	Yes (<)	No	No	Yes (<)	No	No	No	No
2B-SS13	1.25	91.94	0.00	67.46	0.00	114.80	0.00	No	No	No	No	Yes (<)	No	No	No	No
2B-SS14	0.00	48.31	0.00	35.44	0.00	60.32	0.00	No	Yes (<)	No	No	Yes (<)	No	No	Yes (<)	No
2B-SS31	2.50	142.74	0.00	104.73	0.00	178.25	0.00	No	Yes (>)	Yes (>)	No	No	Yes (>)	No	Yes (>)	Yes (>)
2B-SS33	1.25	50.00	0.00	36.69	0.00	62.44	0.00	No	Yes (<)	No	No	Yes (<)	No	No	No	No
2B-SS34 ⁴	98.75	-	-	-	-	-	-	Yes (>)	-	-	Yes (>)	-	-	Yes (>)	-	-
2B-SS41	2.50	104.84	0.00	76.92	0.00	130.92	0.00	No	No	Yes (>)	No	Yes (<)	Yes (>)	No	No	Yes (>)
2B-SS44	0.00	77.82	0.00	57.10	0.00	97.18	0.00	No	No	Yes (>)	No	Yes (<)	Yes (>)	No	No	Yes (>)
2B-SS49	3.75	127.42	0.00	93.49	0.00	159.11	0.00	No	No	No	No	No	No	No	Yes (>)	No

¹ Mean mortality was calculated by averaging the percent mortality of the replicates from each treatment sample.

² Weight loss was calculated by dividing the mean weight loss (g) of each test site sample by the mean weight loss of each reference sample, expressed as a percent. Reproduction was calculated by dividing the mean reproduction count of each test site sample by the mean reproduction count of each reference sample, expressed as a percent.

³ Hypothesis testing for mortality and reproduction was performed using Kruskal-Wallis ANOVA on ranks with Dunn's Method ($P < 0.05$) for nonparametric data. Hypothesis testing for weight loss was performed using one-way ANOVA with Bonferroni t-test ($P < 0.05$) for parametric data. (<) denotes statistical differences that were significantly less than the reference. (>) denotes statistical differences that were significantly greater than the reference.

⁴ Sediment treatment 2B-SS34 had 1 specimen out of 80 survive until test termination. The sample size was too small to be conducive to hypothesis testing and was excluded from weight loss and reproduction statistical comparisons.

Table 6
Comparison of SWMU 2 Site and Reference Results and Hypothesis Testing to
Laboratory Control Results of Whole Sediment Toxicity Test with *L. plumulosus*

Sample ID	Mean Mortality ¹ (%)	Endpoints Compared to Lab Control		Significantly Different from Lab Control		
		Dried Weight ² (%)	Reproduction ³ (%)	Mortality ⁴	Dried Weight ⁵	Reproduction ⁴
Lab Control	3.13	-	-	-	-	-
2B-REF-EWSD-01	6.25	99.06	110.30	No	No	No
2B-REF-EWSD-02	6.25	120.75	154.05	No	Yes (>)	No
2B-EWSD-04	80.00	50.57	74.66	No	Yes (<)	No
2B-EWSD-09	99.38	-	0.00	Yes (>)	-	No
2B-EWSD-12	96.88	-	0.00	Yes (>)	-	No
2B-EWSD-15	97.50	-	0.00	Yes (>)	-	No
2B-EWSD-16	90.63	66.79	136.82	No	Yes (<)	No
2B-EWSD-18	100.00	-	-	Yes (>)	-	-
2B-EWSD-20	92.50	39.34	70.44	Yes (>)	Yes (<)	No
2B-EWSD-24	100.00	-	-	Yes (>)	-	-

¹ Mean mortality was calculated by averaging the percent mortality of the replicates from each treatment sample.

² Dried weight was calculated by dividing the mean dried weight (mg) of each test site sample by the mean dried weight of the lab control, expressed as a percent.

³ Reproduction was calculated by dividing the mean reproduction count of each test site sample by the mean reproduction count of the lab control, expressed as a percent.

⁴ Hypothesis testing for mortality and reproduction was performed using Kruskal-Wallis ANOVA on ranks with Dunn's Method ($P < 0.05$) for nonparametric data. (<) denotes statistical differences that were significantly less than the lab control. (>) denotes statistical differences that were significantly greater than the lab control.

⁵ Hypothesis testing for dried weight was performed using one-way ANOVA with Bonferroni t-test ($P < 0.05$) for parametric data. (>) denotes statistical differences that were significantly greater than the lab control.

Table 7
Comparison of SWMU 2 Site and Reference Results and Hypothesis Testing to
Reference Results of Whole Sediment Toxicity Test with *L. plumulosus*

Sample ID	Mean Mortality ³ (%)	Growth Compared to References ¹				Results Significantly Different from References ²					
		2B-REF-EWSD-01		2B-REF-EWSD-02		2B-REF-EWSD-01			2B-REF-EWSD-02		
		Dried Weight (%)	Repro (%)	Dried Weight (%)	Repro (%)	Mortality	Dried Weight	Repro	Mortality	Dried Weight	Repro
2B-REF-EWSD-01	6.25	-	-	82.03	71.60	-	-	-	No	Yes (<)	No
2B-REF-EWSD-02	6.25	121.90	139.66	-	-	No	Yes (>)	No	-	-	-
2B-EWSD-04	80.00	51.05	67.69	41.88	48.46	No	Yes (<)	No	No	Yes (<)	No
2B-EWSD-09 ⁴	99.38	-	0.00	-	0.00	Yes (>)	-	No	Yes (>)	-	No
2B-EWSD-12 ⁴	96.88	-	0.00	-	0.00	Yes (>)	-	No	Yes (>)	-	No
2B-EWSD-15 ⁴	97.50	-	0.00	-	0.00	Yes (>)	-	No	Yes (>)	-	No
2B-EWSD-16	90.63	67.43	124.04	55.31	88.82	No	Yes (<)	No	No	Yes (<)	No
2B-EWSD-18	100.00	-	-	-	-	Yes (>)	-	-	Yes (>)	-	-
2B-EWSD-20	92.50	39.71	63.86	32.58	45.72	Yes (>)	Yes (<)	No	Yes (>)	Yes (<)	No
2B-EWSD-24	100.00	-	-	-	-	Yes (>)	-	-	Yes (>)	-	-

¹ Dried weight was calculated by dividing the mean dried weight of each test site sample by the mean dried weight of each reference sample, expressed as a percent. Reproduction was calculated by dividing the mean reproduction count of each test site sample by the mean reproduction count of each reference sample, expressed as a percent.

² Hypothesis testing for mortality and reproduction was performed using Kruskal-Wallis ANOVA on ranks with Dunn's Method ($P < 0.05$) for nonparametric data. Hypothesis testing for dried weight was performed using one-way ANOVA with Bonferroni t-test ($P < 0.05$) for parametric data. (<) denotes statistical differences that were significantly less than the reference. (>) denotes statistical differences that were significantly greater than the reference.

³ Mean mortality was calculated by averaging the percent mortality of the replicates from each treatment sample.

⁴ Biomass recovered from each treatment replicate was insufficient for weight determination after drying in oven.

Table 8
Comparison of SWMU 2 Site and Reference Results and Hypothesis Testing to
Laboratory Control Results of Whole Sediment Toxicity Test with *N. arenaceodentata*

Sample ID	Mean Mortality ² (%)	Dried Weight ³ (%)	Significantly Different from Lab Control ¹	
			Mortality	Dried Weight
Lab Control	17.50	-	-	-
2B-REF-EWSD-01	26.25	218.08	No	Yes (>)
2B-REF-EWSD-02	47.5	170.41	Yes (>)	No
2B-EWSD-04	15.00	255.20	No	Yes (>)
2B-EWSD-09	73.75	178.50	Yes (>)	No
2B-EWSD-12	16.25	183.63	No	No
2B-EWSD-15	10.00	296.21	No	Yes (>)
2B-EWSD-16	20.00	219.46	No	Yes (>)
2B-EWSD-18	6.25	247.85	No	Yes (>)
2B-EWSD-20	46.25	158.76	No	No
2B-EWSD-24	50.00	27943	Yes (>)	Yes (>)

¹ Hypothesis testing for mortality and dried weight was performed using one-way ANOVA with Bonferroni t-test ($P < 0.05$) for parametric data. (>) denotes statistical differences that were significantly greater than the lab control.

² Mean mortality was calculated by averaging the percent mortality of the replicates from each treatment sample.

³ Dried weight was calculated by dividing the mean dried weight (mg) of each test site sample by the mean dried weight of the lab control, expressed as a percent.

Table 9
Comparison of SWMU 2 Site and Reference Results and Hypothesis Testing to
Reference Results of Whole Sediment Toxicity Test with *N. arenaceodentata*

	Mean Mortality ³ (%)	Dried Weight ¹ (%)		Results Significantly Different from References ²			
		Compared to References		2B-REF-EWSD-01		2B-REF-EWSD-02	
		2B-REF- EWSD-01	2B-REF- EWSD-02	Mortality	Dried Weight	Mortality	Dried Weight
2B-REF-EWSD-01	26.25	-	127.97	-	-	No	No
2B-REF-EWSD-02	47.5	78.14	-	No	No	-	-
2B-EWSD-04	15.00	117.02	149.76	No	No	Yes (<)	No
2B-EWSD-09	73.75	81.85	104.75	Yes (>)	No	No	No
2B-EWSD-12	16.25	84.21	107.76	No	No	Yes (<)	No
2B-EWSD-15	10.00	135.83	173.82	No	No	Yes (<)	Yes (>)
2B-EWSD-16	20.00	100.64	128.78	No	No	Yes (<)	No
2B-EWSD-18	6.25	113.65	145.44	No	No	Yes (<)	No
2B-EWSD-20	46.25	72.80	93.16	No	No	No	No
2B-EWSD-24	50.00	128.13	163.97	No	No	No	Yes (>)

¹ Dried weight was calculated by dividing the mean dried weight of each test site sample by the mean dried weight of each reference sample, expressed as a percent. Reproduction was calculated by dividing the mean reproduction count of each test site sample by the mean reproduction count of each reference sample, expressed as a percent.

² Hypothesis testing for mortality and dried weight was performed using one-way ANOVA with Bonferroni t-test ($P < 0.05$) for parametric data. (<) denotes statistical differences that were significantly less than the reference. (>) denotes statistical differences that were significantly greater than the reference.

³ Mean mortality was calculated by averaging the percent mortality of the replicates from each treatment sample.

ATTACHMENTS:

1. Chains of Custody

2. *Eisenia fetida* Toxicity Test

Endpoint Data

Statistics

Wet Chemistry

3. *Leptocheirus plumulosus* Toxicity Test

Endpoint Data

Statistics

Wet Chemistry

4. *Neanthes arenaceodentata* Toxicity Test

Endpoint Data

Statistics

Wet Chemistry

ATTACHMENTS:

1. Chains of Custody

ZB-021

EnviroSystems, Inc.
1 Lafayette Road
P.O. Box 778
Hampton, N.H. 03843

8462 4707 7086 0402 Voice: 603-926-3345
FAX: 603-926-3521

ESI Job No:

ZB-022

CHAIN OF CUSTODY DOCUMENTATION

Client: <u>Baker Environmental, Inc.</u>	Contact:	Project Name: <u>SWMU 2 STEP 6</u>	Page <u>3</u> of <u>3</u>
Report to: <u>MARK KIMES</u>	Address: <u>100 Airside Drive</u>	Project Number:	
Invoice to: <u>MARK KIMES</u>	Address: <u>Moore Twp, PA 15108</u>	Project Manager: <u>MARK KIMES</u>	
Voice: <u>412 337 7465</u>	Fax:	email: <u>m.kimes@embakercorp.com</u>	Quote No:

[illegible]

Relinquished By: <u>Joseph H. Burenwa</u>	Date: <u>5/24/07</u> Time: <u>1500</u>	Received By: _____	Date: _____ Time: _____
Relinquished By: _____	Date: _____ Time: _____	Received at Lab By: <u>Robert Ruzen</u>	Date: <u>5/25/07</u> Time: <u>0930</u>
Comments: <u>① Per instructions from Joseph H. Burenwa. PR</u>			

CHAIN OF CUSTODY DOCUMENTATION

Client: Baker Environmental		Contact:		Project Name: SUMMIT 2 STEP 6		Page 1 of 3					
Report to: MARK KIMES		Address: 100 Airside Drive		Project Number:							
Invoice to: MARK KIMES		Address: Moon Twp, PA 15108		Project Manager: Mark Kimes							
Voice: 412 337 7465		Fax:		email: mkimes@mbakercorp.com		Quote No:					
Protocol: RCRA		SDWA		NPDES		USCOE					
Other											
Lab Number (assigned by lab)	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or com- posit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preser- vation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested/ Special Instructions:
	2B-EWSD -04	5/19/07		830	C	1 Gal	P	NA	S		28 Day ToX TEST ↓
	2B-EWSD -09	5/21/07		1020	C	1 Gal	P	NA	S		
	2B-EWSD -12	5/21/07		1120	C	1 Gal	P	NA	S		
	2B-EWSD -15	5/24/07		1315	C	1 Gal	P	NA	S		
	2B-EWSD -16	5/24/07		1300	C	1 Gal	P	NA	S		
	2B-EWSD -18	5/24/07		1350	C	1 Gal	P	NA	S		
	2B-EWSD -20	5/24/07		1425	C	1 Gal	P	NA	S		
	2B-EWSD -24	5/27/07	✓	1545	C	1 Gal	P	NA	S		
	2B-REF-EWSD -01	5/27/07	5/20/07	930	C	1 Gal	P	NA	S		
	2B-REF-EWSD -02	5/24/07	5/20/07	950	C	1 Gal	P	NA	S		
		1143									
Relinquished By: [Signature]				Date: 5/24/07 Time: 1500		Received By:		Date:		Time:	
Relinquished By:				Date:		Received at Lab By:		Date:		Time:	

ESI

EnviroSystems, Inc.
1 Lafayette Road
P.O. Box 778
Hampton, N.H. 03843

8462 4707 7086 0402

Voice: 603-926-3345
FAX: 603-926-3521

ESI Job No:

ZB-021

CHAIN OF CUSTODY DOCUMENTATION

Client: <u>Baker Environmental, Inc.</u>	Contact:	Project Name: <u>SUMU 2 STEP 6</u>	Page <u>2</u> of <u>3</u>
Report to: <u>MARK Kimes</u>	Address: <u>100 Airside Drive</u>	Project Number:	
Invoice to: <u>MARK Kimes</u>	Address: <u>MOON TWP, PA 15108</u>	Project Manager: <u>MARK Kimes</u>	
Voice: <u>412 337 7465</u>	Fax:	email: <u>mkimes@mbakercorp.com</u>	Quote No:

Protocol:	RCRA	SDWA	NPDES	USCOE	Other						
Lab Number (assigned by lab)	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or com- posit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preser- vation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested/ Special Instructions:
	2B-SS04	5/24/07	5/18/07	1400	C	1gal	P	NA	S		28 DAY TOX TEST
	2B-SS05	5/24/07		1430	C	1gal	P	NA	S		
	2B-SS04-01	5/24/07		1405	C	1gal	P	NA	S		
	2B-SS10	5/24/07		1600	C	1gal	P	NA	S		
	2B-SS13	5/24/07		720	C	1gal	P	NA	S		
	2B-SS14	5/24/07		725	C	1gal	P	NA	S		
	2B-SS31	5/24/07		1225	G	1gal	P	NA	S		
	2B-SS33	5/24/07		1335	G	1gal	P	NA	S		
	2B-SS34	5/24/07		1240	C	1gal	P	NA	S		
	2B-SS41	5/24/07		1610	C	1gal	P	NA	S		
	2B-SS44	5/24/07		1625	C	1gal	P	NA	S		
	2B-SS49	5/24/07	✓	1700	C	1gal	P	NA	S		

Relinquished By: <u>[Signature]</u>	Date: <u>5/24/07</u>	Time: <u>1500</u>	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received at Lab By:	Date:	Time:

Comments:

No: Nº 2241

Sample Delivery Group No:

Page

of

ESI

EnviroSystems, Inc.
1 Lafayette Road
P.O. Box 778
Hampton, N.H. 03843

8462 4707 7086 0400
Voice: 603-926-3345
FAX: 603-926-3521

ESI Job No:

ZB-022

CHAIN OF CUSTODY DOCUMENTATION

Client: <u>Baker Environmental, Inc.</u>	Contact:	Project Name: <u>SWMU 2 STEP 6</u>	Page <u>3</u> of <u>3</u>
Report to: <u>MARK KIMES</u>	Address: <u>100 Airside Drive</u>	Project Number:	
Invoice to: <u>MARK KIMES</u>	Address: <u>Moore Twp, PA 15108</u>	Project Manager: <u>MARK KIMES</u>	
Voice: <u>412 337 7465</u>	Fax:	email: <u>m.kimes@mbakercorp.com</u>	Quote No:

Protocol:		RCRA	SDWA	NPDES	USCOE	Other						
Lab Number (assigned by lab)	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or com- posit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preser- vation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested/ Special Instructions:	
	2B-REF-SB01-01	5/24/07	5/24/07	1320	C	1gal	P	NA	S		28 Day TOX TEST ↓	
	2B-REF-SS04	5/24/07	5/24/07	1330	C	1gal	P	NA	S			
	2B-REF-SS05	5/24/07	5/24/07	1400	C	1gal	P	NA	S			

Relinquished By: <u>[Signature]</u>	Date: <u>5/24/07</u>	Time: <u>1500</u>	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received at Lab By:	Date:	Time:

Comments:

No: 2240

Sample Delivery Group No:

Page

of

PLEASE COMPLETE THIS FORM AS THOROUGHLY AS POSSIBLE, USING BLACK INK

info@fortlabs.com

Client: CH2M HILL
Submit Report To: JOHN MALINOWSKI
Sampler's Signature: Warren Hanson
P.O. #:

Lab Use Only
Client/Project # - WO #
CH2M 06-00146

Sample #	Sample Location	Sample Collected Date-Time	# of Cont.	Cont. Type P/G	Type of Preserv.	Analysis Requested	# OF WORMS	TOTAL WEIGHT(g)	Lab Use Only		
									ID#	Temp	pH
0146-026	2B-SS04 RED WORMS	7/3/07-1530	1	G	FROZEN	BIOACCUMULATION	78	18.1874			
027	2B-SS05						78	17.2142			
028	2B-SS10						79	21.8649			
029	2B-SS13						79	20.6405			
030	2B-SS14						80	20.8651			
031	2B-SS31						78	18.0450			
032	2B-SS33						79	19.5892			
033	2B-SS34						1	0.1113			
034	2B-SS41						78	21.9623			
035	2B-SS44						80	19.6655			
036	2B-SS49						77	19.4012			
037	2B-REF-SB01-01						80	21.0413			
038	2B-REF-SS04						80	19.7799			
039	2B-REF-SS05						80	18.0034			
040	LAB CONTROL						79	20.3247			

DATE:
INITIALS:

SPECIAL INSTRUCTIONS:

SPECIAL INSTRUCTIONS:
EACH SAMPLE IS A COMPOSITE OF 8 REPLICATES FROM EACH SOIL TREATMENT, WITH EXCEPTION
OF SOIL TREATMENT 2B-SS04-01 WHICH HAD NO SURVIVORS. TREATMENT 2B-SS34 HAD ONLY
ONE SURVIVOR. ALL SPECIMENS WERE DEPURATED FOR 24H. BEFORE FREEZING.

Sample Relinquished By:	Date-Time	Sample Received By:	Date-Time
Robert Rizer	7/9/07-1700		

*UNLESS OTHERWISE NOTED, ALL SAMPLES ARE STORED AT 4° C.

ATTACHMENTS:

2. *Eisenia fetida* Toxicity Test

Endpoint Data

Statistics

Wet Chemistry

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

FEL Sample No.	Sample ID	Rep	Mortality				Weight Loss					Bioaccumulation		Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
-	Lab Ctl	A	10	0.0	1.25	1.25	2.8689	2.6380	0.0231	0.0561	0.014	2.4965	20.3247	6	0.600	0.733	0.033
-	Lab Ctl	B	10	0.0			3.0556	2.7824	0.0273			2.3425		9	0.900		
-	Lab Ctl	C	10	0.0			3.1643	2.7344	0.0430			2.3172		7	0.700		
-	Lab Ctl	D	10	0.0			3.8042	3.2020	0.0602			2.9505		7	0.700		
-	Lab Ctl	E	9	10.0			4.2058	2.7388	0.1467			2.3220		6	0.667		
-	Lab Ctl	F	10	0.0			3.4218	2.7830	0.0639			2.5096		8	0.800		
-	Lab Ctl	G	10	0.0			3.7416	3.1453	0.0596			2.9623		8	0.800		
-	Lab Ctl	H	10	0.0			3.1174	2.8666	0.0251			2.4241		7	0.700		
001	2B-SS04	A	10	0.0	2.50	1.64	2.9847	2.2293	0.0755	0.0977	0.010	2.3673	18.1874	0	0.000	0.000	0.000
001	2B-SS04	B	10	0.0			3.9826	2.8914	0.1091			3.0964		0	0.000		
001	2B-SS04	C	10	0.0			2.7054	2.0066	0.0699			2.0072		0	0.000		
001	2B-SS04	D	10	0.0			2.7344	2.2248	0.0510			2.2664		0	0.000		
001	2B-SS04	E	9	10.0			3.1672	2.1442	0.1023			2.1389		0	0.000		
001	2B-SS04	F	9	10.0			3.2827	2.1561	0.1127			1.7960		0	0.000		
001	2B-SS04	G	10	0.0			3.6435	2.3778	0.1266			2.1900		0	0.000		
001	2B-SS04	H	10	0.0			3.6233	2.2800	0.1343			2.3252		0	0.000		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

FEL Sample No.	Sample ID	Rep	Mortality				Weight Loss					Bioaccumulation		Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
002	2B-SS05	A	10	0.0	2.50	1.64	2.9628	1.9691	0.0994	0.0922	0.006	1.7883	17.2142	0	0.000	0.000	0.000
002	2B-SS05	B	10	0.0			2.9317	2.3692	0.0563			2.2191		0	0.000		
002	2B-SS05	C	10	0.0			3.6206	2.5834	0.1037			2.7051		0	0.000		
002	2B-SS05	D	10	0.0			3.4193	2.4900	0.0929			2.2656		0	0.000		
002	2B-SS05	E	9	10.0			3.0728	2.1962	0.0877			2.1194		0	0.000		
002	2B-SS05	F	9	10.0			2.8718	1.9786	0.0893			1.9898		0	0.000		
002	2B-SS05	G	10	0.0			3.0413	1.8380	0.1203			1.6027		0	0.000		
002	2B-SS05	H	10	0.0			3.5756	2.6974	0.0878			2.5242		0	0.000		
003	2B-SS04-01	A	0	100.0	100.00	0.00	3.3118	-	-	-	-	-	-	0	-	-	-
003	2B-SS04-01	B	0	100.0			3.6292	-	-			-		0	-		
003	2B-SS04-01	C	0	100.0			3.4600	-	-			-		0	-		
003	2B-SS04-01	D	0	100.0			3.2240	-	-			-		0	-		
003	2B-SS04-01	E	0	100.0			3.6493	-	-			-		0	-		
003	2B-SS04-01	F	0	100.0			3.7414	-	-			-		0	-		
003	2B-SS04-01	G	0	100.0			3.7749	-	-			-		0	-		
003	2B-SS04-01	H	0	100.0			3.5436	-	-			-		0	-		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

FEL Sample No.	Sample ID	Rep	Mortality				Weight Loss					Bioaccumulation		Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
004	2B-SS10	A	10	0.0	1.25	1.25	4.0268	3.3177	0.0709	0.0648	0.007	3.2730	21.8649	0	0.000	0.000	0.000
004	2B-SS10	B	10	0.0			3.2845	2.9746	0.0310			2.6609		0	0.000		
004	2B-SS10	C	10	0.0			3.3771	2.8199	0.0557			2.6417		0	0.000		
004	2B-SS10	D	10	0.0			3.8802	3.2122	0.0668			3.0925		0	0.000		
004	2B-SS10	E	10	0.0			3.0533	2.6077	0.0446			2.5602		0	0.000		
004	2B-SS10	F	9	10.0			3.8064	2.9228	0.0884			2.6929		0	0.000		
004	2B-SS10	G	10	0.0			3.3276	2.4646	0.0863			2.5481		0	0.000		
004	2B-SS10	H	10	0.0			3.2344	2.4876	0.0747			2.3956		0	0.000		
005	2B-SS13	A	9	10.0	1.25	1.25	3.4248	2.1964	0.1228	0.1138	0.008	2.1727	20.6405	0	0.000	0.050	0.027
005	2B-SS13	B	10	0.0			3.6357	2.9101	0.0726			2.3944		2	0.200		
005	2B-SS13	C	10	0.0			3.6372	2.4581	0.1179			2.6352		0	0.000		
005	2B-SS13	D	10	0.0			3.8997	2.5732	0.1327			2.5589		0	0.000		
005	2B-SS13	E	10	0.0			4.2086	2.9087	0.1300			2.9251		0	0.000		
005	2B-SS13	F	10	0.0			3.5547	2.6644	0.0890			2.6187		0	0.000		
005	2B-SS13	G	10	0.0			3.6986	2.4088	0.1290			2.5584		1	0.100		
005	2B-SS13	H	10	0.0			3.9388	2.7735	0.1165			2.7771		1	0.100		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

FEL Sample No.	Sample ID	Rep	Mortality				Weight Loss					Bioaccumulation		Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Wt (g)	Day 28 Wet Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
006	2B-SS14	A	10	0.0	0.00	0.00	2.8803	2.7958	0.0085	0.0599	0.013	3.0863	20.8651	2	0.200	0.050	0.033
006	2B-SS14	B	10	0.0			3.7963	2.7426	0.1054			2.7961		0	0.000		
006	2B-SS14	C	10	0.0			3.4140	2.6790	0.0735			2.5816		0	0.000		
006	2B-SS14	D	10	0.0			3.3303	2.5581	0.0772			2.6377		0	0.000		
006	2B-SS14	E	10	0.0			3.1509	2.9521	0.0199			2.7406		2	0.200		
006	2B-SS14	F	10	0.0			3.5499	2.8990	0.0651			2.8455		0	0.000		
006	2B-SS14	G	10	0.0			3.5155	2.5357	0.0980			2.4347		0	0.000		
006	2B-SS14	H	10	0.0			2.0051	1.6882	0.0317			1.7426		0	0.000		
007	2B-SS31	A	10	0.0	2.50	1.64	4.3963	2.8208	0.1576	0.1773	0.010	2.6001	18.0450	10	1.000	0.758	0.067
007	2B-SS31	B	9	10.0			4.4120	2.4176	0.1994			2.3180		8	0.889		
007	2B-SS31	C	10	0.0			3.9050	2.2507	0.1654			2.0001		7	0.700		
007	2B-SS31	D	9	10.0			3.9807	2.0787	0.1902			2.1368		7	0.778		
007	2B-SS31	E	10	0.0			4.4604	2.8055	0.1655			2.5681		9	0.900		
007	2B-SS31	F	10	0.0			3.6740	2.0977	0.1576			1.7162		8	0.800		
007	2B-SS31	G	10	0.0			4.4205	2.1066	0.2314			2.1291		4	0.400		
007	2B-SS31	H	10	0.0			4.0985	2.5821	0.1516			2.5766		6	0.600		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

FEL Sample No.	Sample ID	Rep	Mortality				Weight Loss					Bioaccumulation		Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
008	2B-SS33	A	10	0.0	1.25	1.25	3.0883	2.5460	0.0542	0.0620	0.010	2.1815	19.5892	0	0.000	0.000	0.000
008	2B-SS33	B	10	0.0			3.5740	2.9052	0.0669			2.5042		0	0.000		
008	2B-SS33	C	10	0.0			3.5503	2.9085	0.0642			2.6013		0	0.000		
008	2B-SS33	D	10	0.0			3.4903	3.3832	0.0107			2.5011		0	0.000		
008	2B-SS33	E	10	0.0			3.4450	2.8545	0.0591			2.4266		0	0.000		
008	2B-SS33	F	9	10.0			2.9012	2.4944	0.0407			2.0704		0	0.000		
008	2B-SS33	G	10	0.0			3.8533	2.8466	0.1007			2.3598		0	0.000		
008	2B-SS33	H	10	0.0			4.3238	3.3263	0.0998			2.9443		0	0.000		
009	2B-SS34	A	0	100.0	98.75	1.25	3.9470	-	-	0.3446	0.000	-	0.1113	-	-	0.000	0.000
009	2B-SS34	B	0	100.0			3.4635	-	-			-		-	-		
009	2B-SS34	C	0	100.0			3.6062	-	-			-		-	-		
009	2B-SS34	D	0	100.0			4.4494	-	-			-		-	-		
009	2B-SS34	E	1	90.0			3.5145	0.0690	0.3446			0.1113		0	0.000		
009	2B-SS34	F	0	100.0			3.9437	-	-			-		-	-		
009	2B-SS34	G	0	100.0			3.4859	-	-			-		-	-		
009	2B-SS34	H	0	100.0			3.8385	-	-			-		-	-		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

FEL Sample No.	Sample ID	Rep	Mortality				Weight Loss					Bioaccumulation		Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
010	2B-SS41	A	10	0.0	2.50	1.64	4.2987	2.8840	0.1415	0.1295	0.008	2.8330	21.9623	6	0.600	0.531	0.056
010	2B-SS41	B	10	0.0			4.5834	3.2983	0.1285			3.0595		6	0.600		
010	2B-SS41	C	10	0.0			4.3683	3.2913	0.1077			2.9034		4	0.400		
010	2B-SS41	D	10	0.0			4.1334	2.9490	0.1184			2.6369		5	0.500		
010	2B-SS41	E	9	10.0			4.5403	2.7785	0.1762			2.6140		6	0.667		
010	2B-SS41	F	10	0.0			4.0348	2.7805	0.1254			2.7581		3	0.300		
010	2B-SS41	G	10	0.0			3.9347	2.8152	0.1120			2.5626		4	0.400		
010	2B-SS41	H	9	10.0			4.1190	2.8550	0.1264			2.5948		7	0.778		
011	2B-SS44	A	10	0.0	0.00	0.00	3.6237	2.7009	0.0923	0.0965	0.011	2.7285	19.6655	2	0.200	0.450	0.057
011	2B-SS44	B	10	0.0			3.7748	2.8921	0.0883			2.6370		7	0.700		
011	2B-SS44	C	10	0.0			3.2765	2.4953	0.0781			2.3290		5	0.500		
011	2B-SS44	D	10	0.0			3.5015	2.5990	0.0903			2.5926		4	0.400		
011	2B-SS44	E	10	0.0			2.8982	2.1321	0.0766			2.0769		5	0.500		
011	2B-SS44	F	10	0.0			2.9496	2.3001	0.0650			2.0602		3	0.300		
011	2B-SS44	G	10	0.0			4.7085	3.1161	0.1592			2.8961		4	0.400		
011	2B-SS44	H	10	0.0			3.8439	2.6216	0.1222			2.3452		6	0.600		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

FEL Sample No.	Sample ID	Rep	Mortality				Weight Loss					Bioaccumulation		Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
012	2B-SS49	A	10	0.0	3.75	2.63	3.9219	2.5182	0.1404	0.1576	0.009	2.6598	19.4012	1	0.100	0.050	0.027
012	2B-SS49	B	10	0.0			4.2460	2.8186	0.1427			2.6904		1	0.100		
012	2B-SS49	C	8	20.0			4.2186	2.1182	0.2100			2.0922		0	0.000		
012	2B-SS49	D	10	0.0			3.8618	2.4106	0.1451			2.3573		0	0.000		
012	2B-SS49	E	10	0.0			3.6118	2.3643	0.1248			2.4569		0	0.000		
012	2B-SS49	F	10	0.0			4.1819	2.5694	0.1613			2.4733		2	0.200		
012	2B-SS49	G	9	10.0			3.9134	2.1243	0.1789			2.1352		0	0.000		
012	2B-SS49	H	10	0.0			3.9650	2.3862	0.1579			2.5361		0	0.000		
013	2B-REF-SS01-01	A	10	0.0	0.00	0.00	3.6157	2.2766	0.1339	0.1238	0.008	2.1744	21.0413	0	0.000	0.000	0.000
013	2B-REF-SS01-01	B	10	0.0			2.9233	2.0478	0.0876			1.9030		0	0.000		
013	2B-REF-SS01-01	C	10	0.0			3.8498	2.5867	0.1263			2.5003		0	0.000		
013	2B-REF-SS01-01	D	10	0.0			3.7845	2.8687	0.0916			2.5477		0	0.000		
013	2B-REF-SS01-01	E	10	0.0			4.4665	3.1113	0.1355			3.0591		0	0.000		
013	2B-REF-SS01-01	F	10	0.0			4.7512	3.2002	0.1551			3.2675		0	0.000		
013	2B-REF-SS01-01	G	10	0.0			4.3715	3.1578	0.1214			2.7932		0	0.000		
013	2B-REF-SS01-01	H	10	0.0			4.2920	2.9051	0.1387			2.7961		0	0.000		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

FEL Sample No.	Sample ID	Rep	Mortality				Weight Loss					Bioaccumulation		Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Day 0 Wet Worm Wt (g)	Day 28 Wet Worm Wt (g)	Wt Loss/ Worm/ Replicate (g)	Mean Wt Loss/ Worm (g)	Wt Loss SEM	Day 29 Wet Worm Wt (g)	Total Wet Wt/ Sample (g)	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Repro SEM
014	2B-REF-SS04	A	10	0.0	0.00	0.00	4.5920	2.4864	0.2106	0.1692	0.010	2.6487	19.7799	0	0.000	0.000	0.000
014	2B-REF-SS04	B	10	0.0			4.0833	2.0118	0.2072			2.1644		0	0.000		
014	2B-REF-SS04	C	10	0.0			3.9746	2.3989	0.1576			2.4790		0	0.000		
014	2B-REF-SS04	D	10	0.0			4.1969	2.5985	0.1598			2.7176		0	0.000		
014	2B-REF-SS04	E	10	0.0			3.9622	2.6335	0.1329			2.6872		0	0.000		
014	2B-REF-SS04	F	10	0.0			3.8362	2.0490	0.1787			2.1392		0	0.000		
014	2B-REF-SS04	G	10	0.0			4.2284	2.6285	0.1600			2.5925		0	0.000		
014	2B-REF-SS04	H	10	0.0			3.8365	2.3653	0.1471			2.3513		0	0.000		
015	2B-REF-SS05	A	10	0.0	0.00	0.00	3.6015	2.3293	0.1272	0.0993	0.009	2.2580	18.0034	0	0.000	0.000	0.000
015	2B-REF-SS05	B	10	0.0			3.6752	2.5295	0.1146			2.2167		0	0.000		
015	2B-REF-SS05	C	10	0.0			3.9167	2.9926	0.0924			2.5135		0	0.000		
015	2B-REF-SS05	D	10	0.0			3.8334	2.8475	0.0986			2.4433		0	0.000		
015	2B-REF-SS05	E	10	0.0			3.4990	2.1588	0.1340			2.1025		0	0.000		
015	2B-REF-SS05	F	10	0.0			3.4672	2.5668	0.0900			2.1621		0	0.000		
015	2B-REF-SS05	G	10	0.0			2.9250	2.2982	0.0627			1.8912		0	0.000		
015	2B-REF-SS05	H	10	0.0			3.4259	2.6781	0.0748			2.4161		0	0.000		

Figure 1
CH2M06-00146 (SWMU 2)
28-d Soil Toxicity Test with *Eisenia fetida*

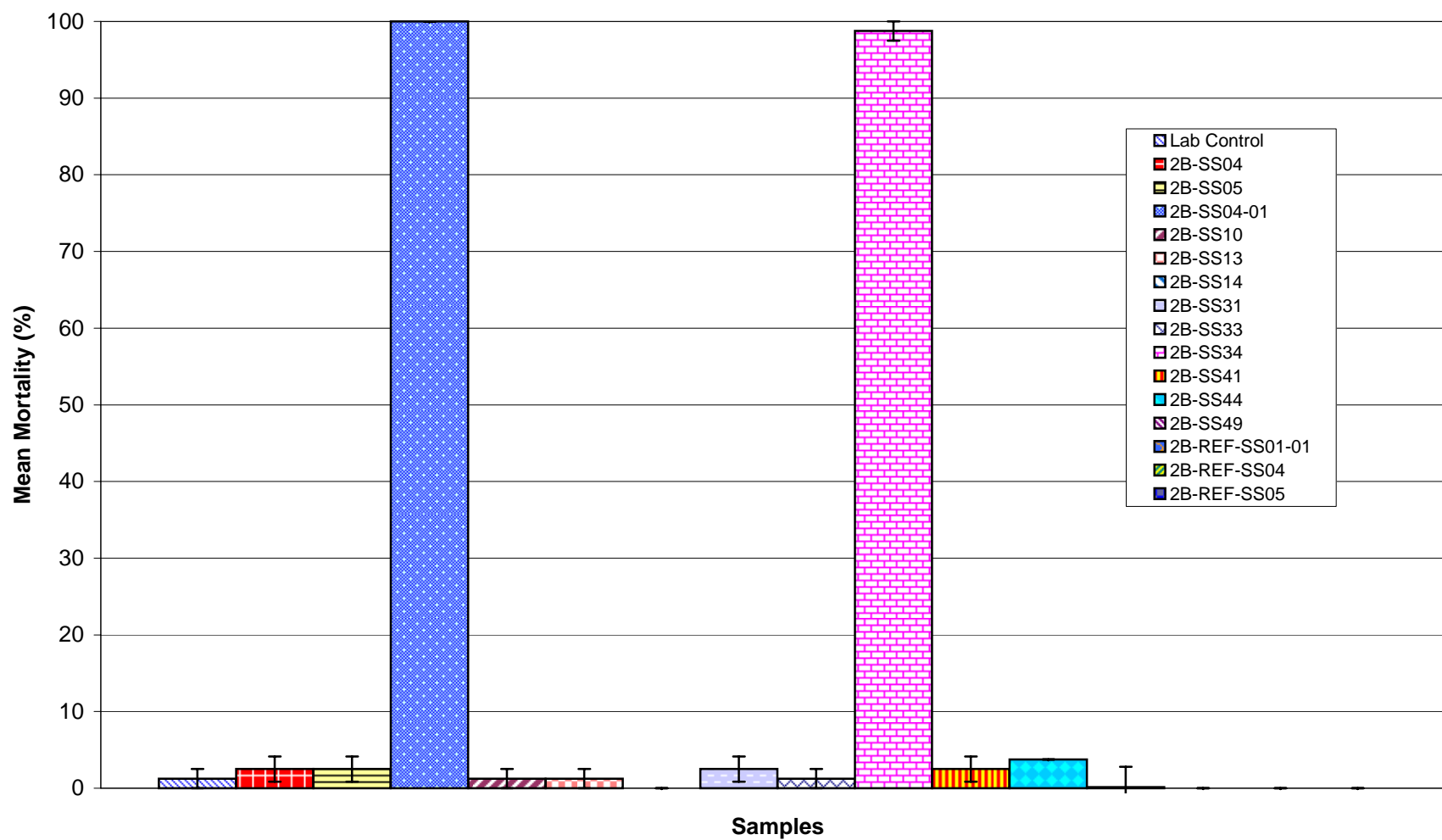


Figure 2
CH2M06-00146 (SWMU 2)
28-d Soil Toxicity Test with *Eisenia fetida*

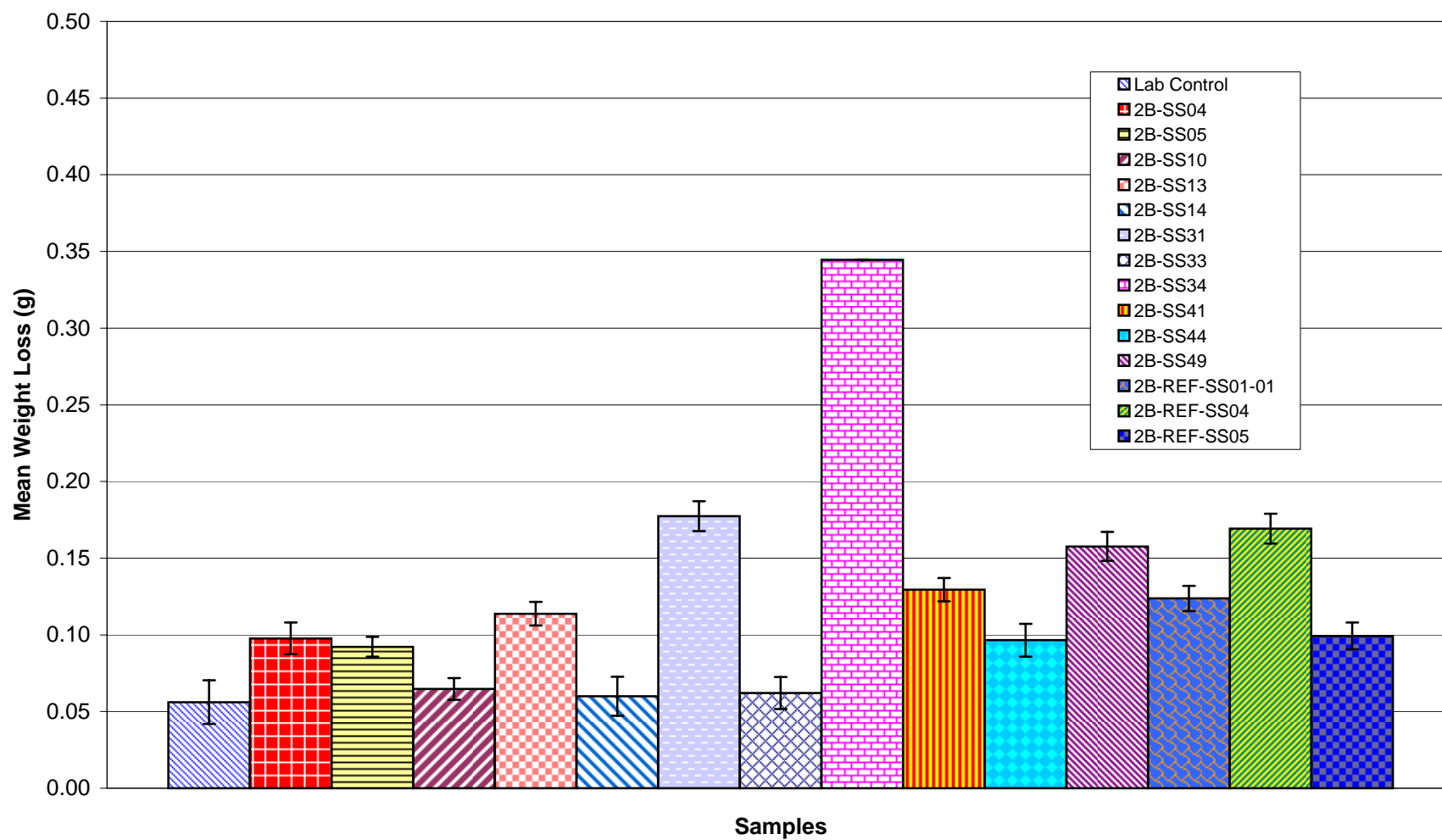
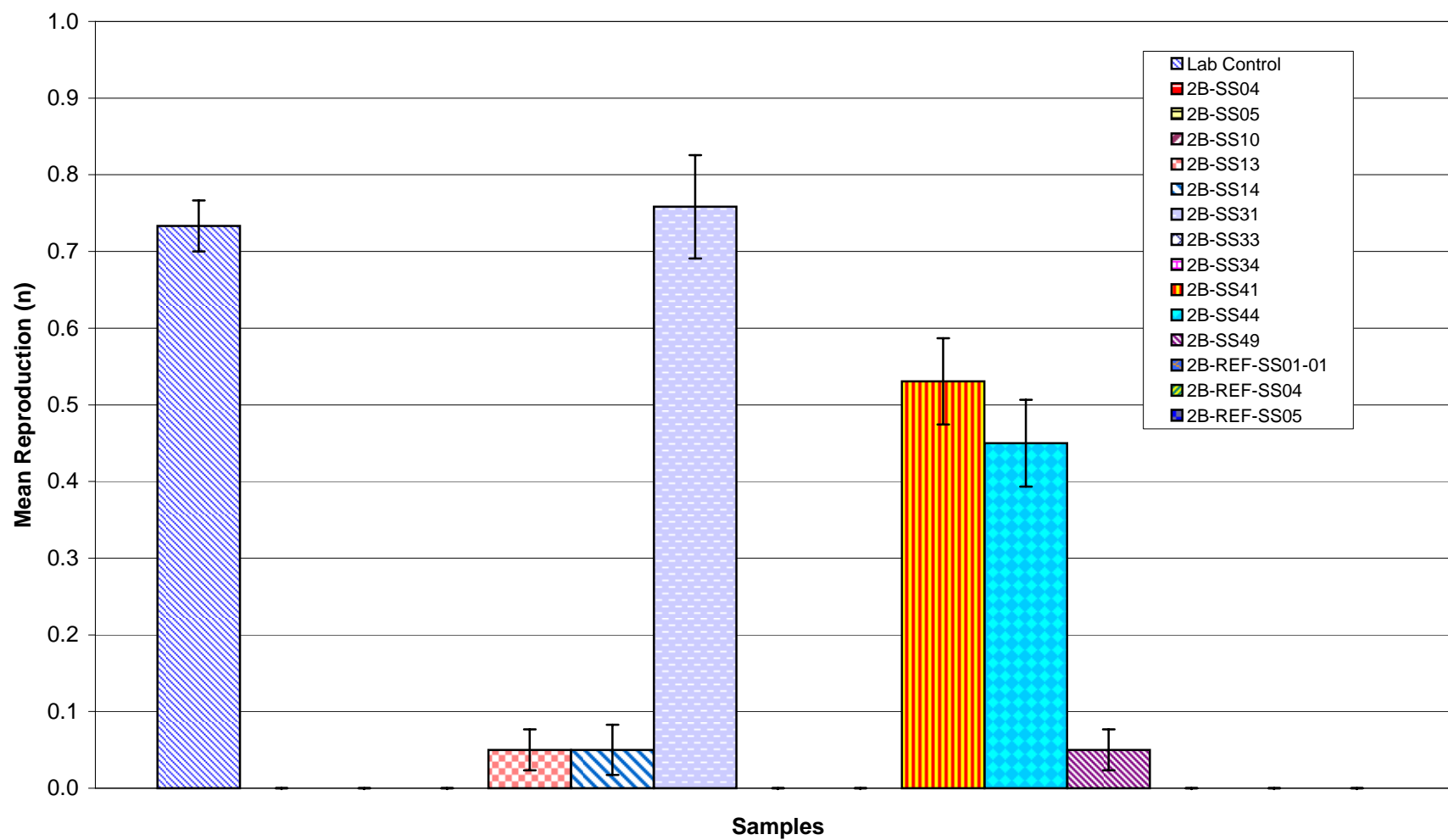


Figure 3
CH2M06-00146 (SWMU 2)
28-d Soil Toxicity Test with *Eisenia fetida*



Descriptive Statistics:

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
LabCtl	8	0	0.0125	0.0354	0.0125	0.0296
2B-REF01-01	8	0	0	0	0	0
2B-REF04	8	0	0	0	0	0
2B-REF05	8	0	0	0	0	0
2B-SS04	8	0	0.025	0.0463	0.0164	0.0387
2B-SS05	8	0	0.025	0.0463	0.0164	0.0387
2B-SS04-01	8	0	1	0	0	0
2B-SS10	8	0	0.0125	0.0354	0.0125	0.0296
2B-SS13	8	0	0.0125	0.0354	0.0125	0.0296
2B-SS14	8	0	0	0	0	0
2B-SS31	8	0	0.025	0.0463	0.0164	0.0387
2B-SS33	8	0	0.0125	0.0354	0.0125	0.0296
2B-SS34	8	0	0.988	0.0354	0.0125	0.0296
2B-SS41	8	0	0.025	0.0463	0.0164	0.0387
2B-SS44	8	0	0	0	0	0
2B-SS49	8	0	0.0375	0.0744	0.0263	0.0622

Column	Range	Max	Min	Median	5%	95%
LabCtl	0.1	0.1	0	0	0	0.1
2B-REF01-01	0	0	0	0	0	0
2B-REF04	0	0	0	0	0	0
2B-REF05	0	0	0	0	0	0
2B-SS04	0.1	0.1	0	0	0	0.1
2B-SS05	0.1	0.1	0	0	0	0.1
2B-SS04-01	0	1	1	1	1	1
2B-SS10	0.1	0.1	0	0	0	0.1
2B-SS13	0.1	0.1	0	0	0	0.1
2B-SS14	0	0	0	0	0	0
2B-SS31	0.1	0.1	0	0	0	0.1
2B-SS33	0.1	0.1	0	0	0	0.1
2B-SS34	0.1	1	0.9	1	0.9	1
2B-SS41	0.1	0.1	0	0	0	0.1
2B-SS44	0	0	0	0	0	0
2B-SS49	0.2	0.2	0	0	0	0.2

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
LabCtl	2.828	8	0.513	<0.001	0.1	0.01
2B-REF01-01	0	-2.8	0	<0.001	0	0
2B-REF04	0	-2.8	0	<0.001	0	0
2B-REF05	0	-2.8	0	<0.001	0	0
2B-SS04	1.44	0	0.455	<0.001	0.2	0.02
2B-SS05	1.44	0	0.455	<0.001	0.2	0.02
2B-SS04-01	0	-2.8	0	<0.001	8	8
2B-SS10	2.828	8	0.513	<0.001	0.1	0.01
2B-SS13	2.828	8	0.513	<0.001	0.1	0.01
2B-SS14	0	-2.8	0	<0.001	0	0
2B-SS31	1.44	0	0.455	<0.001	0.2	0.02
2B-SS33	2.828	8	0.513	<0.001	0.1	0.01
2B-SS34	-2.828	8	0.513	<0.001	7.9	7.81
2B-SS41	1.44	0	0.455	<0.001	0.2	0.02
2B-SS44	0	-2.8	0	<0.001	0	0
2B-SS49	1.951	3.205	0.443	<0.001	0.3	0.05

One Way Analysis of Variance

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Group	N	Missing	Median	25%	75%
asinsqrt-LabCtl	8	0	0	0	0
asinsqrt-REF01-01	8	0	0	0	0
asinsqrt-REF04	8	0	0	0	0
asinsqrt-REF05	8	0	0	0	0
asinsqrt-SS04	8	0	0	0	0.161
asinsqrt-SS05	8	0	0	0	0.161
asinsqrt-SS04-01	8	0	1.571	1.571	1.571
asinsqrt-SS10	8	0	0	0	0
asinsqrt-SS13	8	0	0	0	0
asinsqrt-SS14	8	0	0	0	0
asinsqrt-SS31	8	0	0	0	0.161
asinsqrt-SS33	8	0	0	0	0
asinsqrt-SS34	8	0	1.571	1.571	1.571
asinsqrt-SS41	8	0	0	0	0.161
asinsqrt-SS44	8	0	0	0	0
asinsqrt-SS49	8	0	0	0	0.161

H = 81.210 with 15 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SS04-01 vs asinsqrt-LabCtl	64.563	3.481	Yes
asinsqrt-SS34 vs asinsqrt-LabCtl	63.563	3.427	Yes
asinsqrt-SS49 vs asinsqrt-LabCtl	7.813	0.421	No
asinsqrt-SS44 vs asinsqrt-LabCtl	6.938	0.374	Do Not Test
asinsqrt-SS41 vs asinsqrt-LabCtl	6.938	0.374	Do Not Test
asinsqrt-REF04 vs asinsqrt-LabCtl	6.938	0.374	Do Not Test
asinsqrt-SS31 vs asinsqrt-LabCtl	6.938	0.374	Do Not Test
asinsqrt-SS04 vs asinsqrt-LabCtl	6.938	0.374	Do Not Test
asinsqrt-SS14 vs asinsqrt-LabCtl	6.938	0.374	Do Not Test
asinsqrt-REF01-01 vs asinsqrt-LabCtl	6.938	0.374	Do Not Test
asinsqrt-REF05 vs asinsqrt-LabCtl	6.938	0.374	Do Not Test
asinsqrt-SS05 vs asinsqrt-LabCtl	6.938	0.374	Do Not Test
asinsqrt-SS33 vs asinsqrt-LabCtl	0	0	Do Not Test
asinsqrt-SS10 vs asinsqrt-LabCtl	0	0	Do Not Test
asinsqrt-SS13 vs asinsqrt-LabCtl	0	0	Do Not Test

One Way Analysis of Variance

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Group	N	Missing	Median	25%	75%
asinsqrt-REF0-01	8	0	0	0	0
asinsqrt-REF04	8	0	0	0	0
asinsqrt-REF05	8	0	0	0	0
asinsqrt-SS04	8	0	0	0	0.161
asinsqrt-SS05	8	0	0	0	0.161
asinsqrt-SS04-01	8	0	1.571	1.571	1.571
asinsqrt-SS10	8	0	0	0	0
asinsqrt-SS13	8	0	0	0	0
asinsqrt-SS14	8	0	0	0	0
asinsqrt-SS31	8	0	0	0	0.161
asinsqrt-SS33	8	0	0	0	0
asinsqrt-SS34	8	0	1.571	1.571	1.571
asinsqrt-SS41	8	0	0	0	0.161
asinsqrt-SS44	8	0	0	0	0
asinsqrt-SS49	8	0	0	0	0.161

H = 78.562 with 14 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SS04-01 vs asinsqrt-REF01-01	67	3.852	Yes
asinsqrt-SS34 vs asinsqrt-REF01-01	66	3.795	Yes
asinsqrt-SS49 vs asinsqrt-REF01-01	13.688	0.787	No
asinsqrt-SS41 vs asinsqrt-REF01-01	12.875	0.74	Do Not Test
asinsqrt-SS05 vs asinsqrt-REF01-01	12.875	0.74	Do Not Test
asinsqrt-SS31 vs asinsqrt-REF01-01	12.875	0.74	Do Not Test
asinsqrt-SS04 vs asinsqrt-REF01-01	12.875	0.74	Do Not Test
asinsqrt-SS33 vs asinsqrt-REF01-01	6.438	0.37	Do Not Test
asinsqrt-SS13 vs asinsqrt-REF01-01	6.438	0.37	Do Not Test
asinsqrt-SS10 vs asinsqrt-REF01-01	6.438	0.37	Do Not Test
asinsqrt-REF04 vs asinsqrt-REF01-01	0	0	Do Not Test
asinsqrt-REF05 vs asinsqrt-REF01-01	0	0	Do Not Test
asinsqrt-SS44 vs asinsqrt-REF01-01	0	0	Do Not Test
asinsqrt-SS14 vs asinsqrt-REF01-01	0	0	Do Not Test

One Way Analysis of Variance

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Group	N	Missing	Median	25%	75%
asinsqrt-REF01-01	8	0	0	0	0
asinsqrt-REF04	8	0	0	0	0
asinsqrt-REF05	8	0	0	0	0
asinsqrt-SS04	8	0	0	0	0.161
asinsqrt-SS05	8	0	0	0	0.161
asinsqrt-SS04-01	8	0	1.571	1.571	1.571
asinsqrt-SS10	8	0	0	0	0
asinsqrt-SS13	8	0	0	0	0
asinsqrt-SS14	8	0	0	0	0
asinsqrt-SS31	8	0	0	0	0.161
asinsqrt-SS33	8	0	0	0	0
asinsqrt-SS34	8	0	1.571	1.571	1.571
asinsqrt-SS41	8	0	0	0	0.161
asinsqrt-SS44	8	0	0	0	0
asinsqrt-SS49	8	0	0	0	0.161

H = 78.562 with 14 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SS04-01 vs asinsqrt-REF04	67	3.852	Yes
asinsqrt-SS34 vs asinsqrt-REF04	66	3.795	Yes
asinsqrt-SS49 vs asinsqrt-REF04	13.688	0.787	No
asinsqrt-SS41 vs asinsqrt-REF04	12.875	0.74	Do Not Test
asinsqrt-SS05 vs asinsqrt-REF04	12.875	0.74	Do Not Test
asinsqrt-SS31 vs asinsqrt-REF04	12.875	0.74	Do Not Test
asinsqrt-SS04 vs asinsqrt-REF04	12.875	0.74	Do Not Test
asinsqrt-SS33 vs asinsqrt-REF04	6.438	0.37	Do Not Test
asinsqrt-SS13 vs asinsqrt-REF04	6.438	0.37	Do Not Test
asinsqrt-SS10 vs asinsqrt-REF04	6.438	0.37	Do Not Test
asinsqrt-REF01-01 vs asinsqrt-REF04	0	0	Do Not Test
asinsqrt-REF05 vs asinsqrt-REF04	0	0	Do Not Test
asinsqrt-SS44 vs asinsqrt-REF04	0	0	Do Not Test
asinsqrt-SS14 vs asinsqrt-REF04	0	0	Do Not Test

One Way Analysis of Variance

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Group	N	Missing	Median	25%	75%
asinsqrt-REF01-01	8	0	0	0	0
asinsqrt-REF04	8	0	0	0	0
asinsqrt-REF05	8	0	0	0	0
asinsqrt-SS04	8	0	0	0	0.161
asinsqrt-SS05	8	0	0	0	0.161
asinsqrt-SS04-01	8	0	1.571	1.571	1.571
asinsqrt-SS10	8	0	0	0	0
asinsqrt-SS13	8	0	0	0	0
asinsqrt-SS14	8	0	0	0	0
asinsqrt-SS31	8	0	0	0	0.161
asinsqrt-SS33	8	0	0	0	0
asinsqrt-SS34	8	0	1.571	1.571	1.571
asinsqrt-SS41	8	0	0	0	0.161
asinsqrt-SS44	8	0	0	0	0
asinsqrt-SS49	8	0	0	0	0.161

H = 78.562 with 14 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SS04-01 vs asinsqrt-REF05	67	3.852	Yes
asinsqrt-SS34 vs asinsqrt-REF05	66	3.795	Yes
asinsqrt-SS49 vs asinsqrt-REF05	13.688	0.787	No
asinsqrt-SS41 vs asinsqrt-REF05	12.875	0.74	Do Not Test
asinsqrt-SS05 vs asinsqrt-REF05	12.875	0.74	Do Not Test
asinsqrt-SS31 vs asinsqrt-REF05	12.875	0.74	Do Not Test
asinsqrt-SS04 vs asinsqrt-REF05	12.875	0.74	Do Not Test
asinsqrt-SS33 vs asinsqrt-REF05	6.438	0.37	Do Not Test
asinsqrt-SS13 vs asinsqrt-REF05	6.438	0.37	Do Not Test
asinsqrt-SS10 vs asinsqrt-REF05	6.438	0.37	Do Not Test
asinsqrt-REF01-01 vs asinsqrt-REF05	0	0	Do Not Test
asinsqrt-REF04 vs asinsqrt-REF05	0	0	Do Not Test
asinsqrt-SS44 vs asinsqrt-REF05	0	0	Do Not Test
asinsqrt-SS14 vs asinsqrt-REF05	0	0	Do Not Test

Descriptive Statistics:

Data source: Data_Weight Loss (g) in CH2M01-00146 (SWMU 2)_ *Eisenia fetida*

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean	% Weight Loss Compared to:			
							LabCtl	2B-REF01-01	2B-REF04	2B-REF05
LabCtl	8	0	0.0561	0.0403	0.0142	0.0337	-			
2B-REF01-01	8	0	0.124	0.0233	0.00824	0.0195	221.03	-	73.37	124.87
2B-REF04	8	0	0.169	0.0277	0.00979	0.0231	301.25	136.29	-	170.19
2B-REF05	8	0	0.0993	0.0248	0.00875	0.0207	177.01	80.08	58.76	-
2B-SS04	8	0	0.0977	0.0293	0.0103	0.0245	174.15	78.79	57.81	98.39
2B-SS05	8	0	0.0922	0.0182	0.00642	0.0152	164.35	74.35	54.56	92.85
2B-SS10	8	0	0.0648	0.02	0.00706	0.0167	115.51	52.26	38.34	65.26
2B-SS13	8	0	0.114	0.0216	0.00764	0.0181	203.21	91.94	67.46	114.80
2B-SS14	8	0	0.0599	0.036	0.0127	0.0301	106.77	48.31	35.44	60.32
2B-SS31	8	0	0.177	0.0275	0.00973	0.023	315.51	142.74	104.73	178.25
2B-SS33	8	0	0.062	0.0295	0.0104	0.0247	110.52	50.00	36.69	62.44
2B-SS41	8	0	0.13	0.0216	0.00763	0.018	231.73	104.84	76.92	130.92
2B-SS44	8	0	0.0965	0.0303	0.0107	0.0254	172.01	77.82	57.10	97.18
2B-SS49	8	0	0.158	0.0266	0.00941	0.0223	281.64	127.42	93.49	159.11

Column	Range	Max	Min	Median	5%	95%
LabCtl	0.124	0.147	0.0231	0.0513	0.0231	0.147
2B-REF01-01	0.0675	0.155	0.0876	0.13	0.0876	0.155
2B-REF04	0.0777	0.211	0.133	0.16	0.133	0.211
2B-REF05	0.0713	0.134	0.0627	0.0955	0.0627	0.134
2B-SS04	0.0833	0.134	0.051	0.106	0.051	0.134
2B-SS05	0.064	0.12	0.0563	0.0911	0.0563	0.12
2B-SS10	0.0574	0.0884	0.031	0.0688	0.031	0.0884
2B-SS13	0.0601	0.133	0.0726	0.12	0.0726	0.133
2B-SS14	0.0969	0.105	0.0085	0.0693	0.0085	0.105
2B-SS31	0.0798	0.231	0.152	0.165	0.152	0.231
2B-SS33	0.09	0.101	0.0107	0.0616	0.0107	0.101
2B-SS41	0.0685	0.176	0.108	0.126	0.108	0.176
2B-SS44	0.0942	0.159	0.065	0.0893	0.065	0.159
2B-SS49	0.0852	0.21	0.125	0.152	0.125	0.21

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
LabCtl	1.902	4.253	0.298	0.035	0.449	0.0365
2B-REF01-01	-0.66	-0.451	0.21	0.352	0.99	0.126
2B-REF04	0.578	-0.792	0.256	0.128	1.354	0.234
2B-REF05	0.0298	-0.999	0.136	0.773	0.794	0.0832
2B-SS04	-0.423	-1.093	0.188	0.495	0.781	0.0823
2B-SS05	-0.705	2.345	0.278	0.069	0.737	0.0703
2B-SS10	-0.558	-0.56	0.165	0.641	0.518	0.0364
2B-SS13	-1.321	0.636	0.299	0.033	0.911	0.107
2B-SS14	-0.266	-1.491	0.182	0.531	0.479	0.0378
2B-SS31	1.235	0.837	0.291	0.044	1.419	0.257
2B-SS33	-0.249	0.242	0.185	0.515	0.496	0.0369
2B-SS41	1.637	3.189	0.269	0.092	1.036	0.137
2B-SS44	1.482	2.044	0.305	0.027	0.772	0.0809
2B-SS49	1.084	1.271	0.195	0.444	1.261	0.204

One Way Analysis of Variance

Data source: Data_Weight Loss (g) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.932)

Group Name	N	Missing	Mean	Std Dev	SEM
LabCtl	8	0	0.0561	0.0403	0.0142
2B-REF01-01	8	0	0.124	0.0233	0.00824
2B-REF04	8	0	0.169	0.0277	0.00979
2B-REF05	8	0	0.0993	0.0248	0.00875
2B-SS04	8	0	0.0977	0.0293	0.0103
2B-SS05	8	0	0.0922	0.0182	0.00642
2B-SS10	8	0	0.0648	0.02	0.00706
2B-SS13	8	0	0.114	0.0216	0.00764
2B-SS14	8	0	0.0599	0.036	0.0127
2B-SS31	8	0	0.177	0.0275	0.00973
2B-SS33	8	0	0.062	0.0295	0.0104
2B-SS41	8	0	0.13	0.0216	0.00763
2B-SS44	8	0	0.0965	0.0303	0.0107
2B-SS49	8	0	0.158	0.0266	0.00941

Source of Variation	DF	SS	MS	F	P
Between Groups	13	0.17	0.0131	17.29	<0.001
Residual	98	0.0743	0.000758		
Total	111	0.245			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
LabCtl vs. 2B-SS31	0.121	8.805	<0.001	Yes
LabCtl vs. 2B-REF04	0.113	8.216	<0.001	Yes
LabCtl vs. 2B-SS49	0.102	7.374	<0.001	Yes
LabCtl vs. 2B-SS41	0.0734	5.331	<0.001	Yes
LabCtl vs. 2B-REF01-01	0.0676	4.913	<0.001	Yes
LabCtl vs. 2B-SS13	0.0577	4.191	<0.001	Yes
LabCtl vs. 2B-REF05	0.0432	3.136	0.029	Yes
LabCtl vs. 2B-SS04	0.0416	3.019	0.042	Yes
LabCtl vs. 2B-SS44	0.0404	2.933	0.054	No
LabCtl vs. 2B-SS05	0.0361	2.619	0.133	Do Not Test
LabCtl vs. 2B-SS10	0.00869	0.631	1	Do Not Test
LabCtl vs. 2B-SS33	0.00592	0.43	1	Do Not Test
LabCtl vs. 2B-SS14	0.0038	0.276	1	Do Not Test

One Way Analysis of Variance

Data source: Data_Weight Loss (g) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.932)

Group Name	N	Missing	Mean	Std Dev	SEM
2B-REF01-01	8	0	0.124	0.0233	0.00824
2B-REF04	8	0	0.169	0.0277	0.00979
2B-REF05	8	0	0.0993	0.0248	0.00875
2B-SS04	8	0	0.0977	0.0293	0.0103
2B-SS05	8	0	0.0922	0.0182	0.00642
2B-SS10	8	0	0.0648	0.02	0.00706
2B-SS13	8	0	0.114	0.0216	0.00764
2B-SS14	8	0	0.0599	0.036	0.0127
2B-SS31	8	0	0.177	0.0275	0.00973
2B-SS33	8	0	0.062	0.0295	0.0104
2B-SS41	8	0	0.13	0.0216	0.00763
2B-SS44	8	0	0.0965	0.0303	0.0107
2B-SS49	8	0	0.158	0.0266	0.00941

Source of Variation	DF	SS	MS	F	P
Between Groups	12	0.148	0.0123	17.827	<0.001
Residual	91	0.063	0.000692		
Total	103	0.211			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
2B-REF01-01 vs. 2B-SS14	0.0638	4.855	<0.001	Yes
2B-REF01-01 vs. 2B-SS33	0.0617	4.693	<0.001	Yes
2B-REF01-01 vs. 2B-SS10	0.059	4.483	<0.001	Yes
2B-REF01-01 vs. 2B-SS31	0.0536	4.074	0.001	Yes
2B-REF01-01 vs. 2B-REF04	0.0455	3.458	0.01	Yes
2B-REF01-01 vs. 2B-SS49	0.0339	2.576	0.139	No
2B-REF01-01 vs. 2B-SS05	0.0316	2.402	0.22	Do Not Test
2B-REF01-01 vs. 2B-SS44	0.0273	2.073	0.492	Do Not Test
2B-REF01-01 vs. 2B-SS04	0.0261	1.984	0.604	Do Not Test
2B-REF01-01 vs. 2B-REF05	0.0245	1.861	0.792	Do Not Test
2B-REF01-01 vs. 2B-SS13	0.00995	0.757	1	Do Not Test
2B-REF01-01 vs. 2B-SS41	0.00575	0.437	1	Do Not Test

One Way Analysis of Variance

Data source: Data_Weight Loss (g) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.932)

Group Name	N	Missing	Mean	Std Dev	SEM
2B-REF01-01	8	0	0.124	0.0233	0.00824
2B-REF04	8	0	0.169	0.0277	0.00979
2B-REF05	8	0	0.0993	0.0248	0.00875
2B-SS04	8	0	0.0977	0.0293	0.0103
2B-SS05	8	0	0.0922	0.0182	0.00642
2B-SS10	8	0	0.0648	0.02	0.00706
2B-SS13	8	0	0.114	0.0216	0.00764
2B-SS14	8	0	0.0599	0.036	0.0127
2B-SS31	8	0	0.177	0.0275	0.00973
2B-SS33	8	0	0.062	0.0295	0.0104
2B-SS41	8	0	0.13	0.0216	0.00763
2B-SS44	8	0	0.0965	0.0303	0.0107
2B-SS49	8	0	0.158	0.0266	0.00941

Source of Variation	DF	SS	MS	F	P
Between Groups	12	0.148	0.0123	17.827	<0.001
Residual	91	0.063	0.000692		
Total	103	0.211			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
2B-REF04 vs. 2B-SS14	0.109	8.312	<0.001	Yes
2B-REF04 vs. 2B-SS33	0.107	8.151	<0.001	Yes
2B-REF04 vs. 2B-SS10	0.104	7.941	<0.001	Yes
2B-REF04 vs. 2B-SS05	0.0771	5.859	<0.001	Yes
2B-REF04 vs. 2B-SS44	0.0727	5.531	<0.001	Yes
2B-REF04 vs. 2B-SS04	0.0716	5.441	<0.001	Yes
2B-REF04 vs. 2B-REF05	0.07	5.319	<0.001	Yes
2B-REF04 vs. 2B-SS13	0.0554	4.214	<0.001	Yes
2B-REF04 vs. 2B-REF01-01	0.0455	3.458	0.01	Yes
2B-REF04 vs. 2B-SS41	0.0397	3.02	0.039	Yes
2B-REF04 vs. 2B-SS49	0.0116	0.882	1	No
2B-REF04 vs. 2B-SS31	0.0081	0.616	1	Do Not Test

One Way Analysis of Variance

Data source: Data_Weight Loss (g) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.932)

Group Name	N	Missing	Mean	Std Dev	SEM
2B-REF01-01	8	0	0.124	0.0233	0.00824
2B-REF04	8	0	0.169	0.0277	0.00979
2B-REF05	8	0	0.0993	0.0248	0.00875
2B-SS04	8	0	0.0977	0.0293	0.0103
2B-SS05	8	0	0.0922	0.0182	0.00642
2B-SS10	8	0	0.0648	0.02	0.00706
2B-SS13	8	0	0.114	0.0216	0.00764
2B-SS14	8	0	0.0599	0.036	0.0127
2B-SS31	8	0	0.177	0.0275	0.00973
2B-SS33	8	0	0.062	0.0295	0.0104
2B-SS41	8	0	0.13	0.0216	0.00763
2B-SS44	8	0	0.0965	0.0303	0.0107
2B-SS49	8	0	0.158	0.0266	0.00941

Source of Variation	DF	SS	MS	F	P
Between Groups	12	0.148	0.0123	17.827	<0.001
Residual	91	0.063	0.000692		
Total	103	0.211			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
2B-REF05 vs. 2B-SS31	0.0781	5.934	<0.001	Yes
2B-REF05 vs. 2B-REF04	0.07	5.319	<0.001	Yes
2B-REF05 vs. 2B-SS49	0.0583	4.437	<0.001	Yes
2B-REF05 vs. 2B-SS14	0.0394	2.994	0.043	Yes
2B-REF05 vs. 2B-SS33	0.0372	2.832	0.068	No
2B-REF05 vs. 2B-SS10	0.0345	2.622	0.123	Do Not Test
2B-REF05 vs. 2B-SS41	0.0302	2.298	0.286	Do Not Test
2B-REF05 vs. 2B-REF01-01	0.0245	1.861	0.792	Do Not Test
2B-REF05 vs. 2B-SS13	0.0145	1.104	1	Do Not Test
2B-REF05 vs. 2B-SS05	0.00711	0.541	1	Do Not Test
2B-REF05 vs. 2B-SS44	0.00279	0.212	1	Do Not Test
2B-REF05 vs. 2B-SS04	0.00161	0.123	1	Do Not Test

Descriptive Statistics:

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean	% Reproduction Compared to:			
							LabCtl	2B-REF01-01	2B-REF04	2B-REF05
LabCtl	8	0	0.733	0.0942	0.0333	0.0788	-			
2B-REF01-01	8	0	0	0	0	0	0.00	-	-	-
2B-REF04	8	0	0	0	0	0	0.00	-	-	-
2B-REF05	8	0	0	0	0	0	0.00	-	-	-
2B-SS04	8	0	0	0	0	0	0.00	-	-	-
2B-SS05	8	0	0	0	0	0	0.00	-	-	-
2B-SS10	8	0	0	0	0	0	0.00	-	-	-
2B-SS13	8	0	0.05	0.0756	0.0267	0.0632	6.82	-	-	-
2B-SS14	8	0	0.05	0.0926	0.0327	0.0774	6.82	-	-	-
2B-SS31	8	0	0.758	0.191	0.0674	0.159	103.41	-	-	-
2B-SS33	8	0	0	0	0	0	0.00	-	-	-
2B-SS41	8	0	0.531	0.159	0.0563	0.133	72.44	-	-	-
2B-SS44	8	0	0.45	0.16	0.0567	0.134	61.39	-	-	-
2B-SS49	8	0	0.05	0.0756	0.0267	0.0632	6.82	-	-	-

Column	Range	Max	Min	Median	5%	95%
LabCtl	0.3	0.9	0.6	0.7	0.6	0.9
2B-REF01-01	0	0	0	0	0	0
2B-REF04	0	0	0	0	0	0
2B-REF05	0	0	0	0	0	0
2B-SS04	0	0	0	0	0	0
2B-SS05	0	0	0	0	0	0
2B-SS10	0	0	0	0	0	0
2B-SS13	0.2	0.2	0	0	0	0.2
2B-SS14	0.2	0.2	0	0	0	0.2
2B-SS31	0.6	1	0.4	0.789	0.4	1
2B-SS33	0	0	0	0	0	0
2B-SS41	0.478	0.778	0.3	0.55	0.3	0.778
2B-SS44	0.5	0.7	0.2	0.45	0.2	0.7
2B-SS49	0.2	0.2	0	0	0	0.2

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
LabCtl	0.555	0.0965	0.263	0.104	5.867	4.365
2B-REF01-01	0	-2.8	0	<0.001	0	0
2B-REF04	0	-2.8	0	<0.001	0	0
2B-REF05	0	-2.8	0	<0.001	0	0
2B-SS04	0	-2.8	0	<0.001	0	0
2B-SS05	0	-2.8	0	<0.001	0	0
2B-SS10	0	-2.8	0	<0.001	0	0
2B-SS13	1.323	0.875	0.371	0.002	0.4	0.06
2B-SS14	1.44	0	0.455	<0.001	0.4	0.08
2B-SS31	-0.85	0.608	0.166	0.635	6.067	4.856
2B-SS33	0	-2.8	0	<0.001	0	0
2B-SS41	0.0749	-0.882	0.169	0.617	4.245	2.43
2B-SS44	8.25E-16	-0.311	0.128	0.793	3.6	1.8
2B-SS49	1.323	0.875	0.371	0.002	0.4	0.06

One Way Analysis of Variance

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Group	N	Missing	Median	25%	75%
LabCtl	8	0	0.7	0.684	0.8
2B-REF01-01	8	0	0	0	0
2B-REF04	8	0	0	0	0
2B-REF05	8	0	0	0	0
2B-SS04	8	0	0	0	0
2B-SS05	8	0	0	0	0
2B-SS10	8	0	0	0	0
2B-SS13	8	0	0	0	0.1
2B-SS14	8	0	0	0	0.1
2B-SS31	8	0	0.789	0.65	0.895
2B-SS33	8	0	0	0	0
2B-SS41	8	0	0.55	0.4	0.633
2B-SS44	8	0	0.45	0.35	0.55
2B-SS49	8	0	0	0	0.1

H = 98.014 with 13 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
2B-SS05 vs LabCtl	65.875	4.057	Yes
2B-REF01-01 vs LabCtl	65.875	4.057	Yes
2B-SS10 vs LabCtl	65.875	4.057	Yes
2B-SS33 vs LabCtl	65.875	4.057	Yes
2B-SS04 vs LabCtl	65.875	4.057	Yes
2B-REF05 vs LabCtl	65.875	4.057	Yes
2B-REF04 vs LabCtl	65.875	4.057	Yes
2B-SS14 vs LabCtl	55.25	3.403	Yes
2B-SS13 vs LabCtl	51.063	3.145	Yes
2B-SS49 vs LabCtl	51.063	3.145	Yes
2B-SS44 vs LabCtl	13.813	0.851	No
2B-SS41 vs LabCtl	10.563	0.65	Do Not Test
2B-SS31 vs LabCtl	0.625	0.0385	Do Not Test

One Way Analysis of Variance

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Group	N	Missing	Median	25%	75%
2B-REF01-01	8	0	0	0	0
2B-REF04	8	0	0	0	0
2B-REF05	8	0	0	0	0
2B-SS04	8	0	0	0	0
2B-SS05	8	0	0	0	0
2B-SS10	8	0	0	0	0
2B-SS13	8	0	0	0	0.1
2B-SS14	8	0	0	0	0.1
2B-SS31	8	0	0.789	0.65	0.895
2B-SS33	8	0	0	0	0
2B-SS41	8	0	0.55	0.4	0.633
2B-SS44	8	0	0.45	0.35	0.55
2B-SS49	8	0	0	0	0.1

H = 87.665 with 12 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
2B-SS31 vs 2B-REF01-01	61.813	4.098	Yes
2B-SS41 vs 2B-REF01-01	54.375	3.605	Yes
2B-SS44 vs 2B-REF01-01	51.563	3.419	Yes
2B-SS13 vs 2B-REF01-01	14.813	0.982	No
2B-SS49 vs 2B-REF01-01	14.813	0.982	Do Not Test
2B-SS14 vs 2B-REF01-01	10.625	0.704	Do Not Test
2B-REF04 vs 2B-REF01-01	0	0	Do Not Test
2B-SS10 vs 2B-REF01-01	0	0	Do Not Test
2B-SS33 vs 2B-REF01-01	0	0	Do Not Test
2B-SS05 vs 2B-REF01-01	0	0	Do Not Test
2B-SS04 vs 2B-REF01-01	0	0	Do Not Test
2B-REF05 vs 2B-REF01-01	0	0	Do Not Test

One Way Analysis of Variance

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_*Eisenia fetida*

Group	N	Missing	Median	25%	75%
2B-REF01-01	8	0	0	0	0
2B-REF04	8	0	0	0	0
2B-REF05	8	0	0	0	0
2B-SS04	8	0	0	0	0
2B-SS05	8	0	0	0	0
2B-SS10	8	0	0	0	0
2B-SS13	8	0	0	0	0.1
2B-SS14	8	0	0	0	0.1
2B-SS31	8	0	0.789	0.65	0.895
2B-SS33	8	0	0	0	0
2B-SS41	8	0	0.55	0.4	0.633
2B-SS44	8	0	0.45	0.35	0.55
2B-SS49	8	0	0	0	0.1

H = 87.665 with 12 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
2B-SS31 vs 2B-REF04	61.813	4.098	Yes
2B-SS41 vs 2B-REF04	54.375	3.605	Yes
2B-SS44 vs 2B-REF04	51.563	3.419	Yes
2B-SS13 vs 2B-REF04	14.813	0.982	No
2B-SS49 vs 2B-REF04	14.813	0.982	Do Not Test
2B-SS14 vs 2B-REF04	10.625	0.704	Do Not Test
2B-REF01-01 vs 2B-REF04	0	0	Do Not Test
2B-SS10 vs 2B-REF04	0	0	Do Not Test
2B-SS33 vs 2B-REF04	0	0	Do Not Test
2B-SS05 vs 2B-REF04	0	0	Do Not Test
2B-SS04 vs 2B-REF04	0	0	Do Not Test
2B-REF05 vs 2B-REF04	0	0	Do Not Test

One Way Analysis of Variance

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_Eisenia fetida

Group	N	Missing	Median	25%	75%
2B-REF01-01	8	0	0	0	0
2B-REF04	8	0	0	0	0
2B-REF05	8	0	0	0	0
2B-SS04	8	0	0	0	0
2B-SS05	8	0	0	0	0
2B-SS10	8	0	0	0	0
2B-SS13	8	0	0	0	0.1
2B-SS14	8	0	0	0	0.1
2B-SS31	8	0	0.789	0.65	0.895
2B-SS33	8	0	0	0	0
2B-SS41	8	0	0.55	0.4	0.633
2B-SS44	8	0	0.45	0.35	0.55
2B-SS49	8	0	0	0	0.1

H = 87.665 with 12 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
2B-SS31 vs 2B-REF05	61.813	4.098	Yes
2B-SS41 vs 2B-REF05	54.375	3.605	Yes
2B-SS44 vs 2B-REF05	51.563	3.419	Yes
2B-SS13 vs 2B-REF05	14.813	0.982	No
2B-SS49 vs 2B-REF05	14.813	0.982	Do Not Test
2B-SS14 vs 2B-REF05	10.625	0.704	Do Not Test
2B-REF01-01 vs 2B-REF05	0	0	Do Not Test
2B-SS10 vs 2B-REF05	0	0	Do Not Test
2B-SS33 vs 2B-REF05	0	0	Do Not Test
2B-SS05 vs 2B-REF05	0	0	Do Not Test
2B-SS04 vs 2B-REF05	0	0	Do Not Test
2B-REF04 vs 2B-REF05	0	0	Do Not Test

SOIL CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	pH (su)	TOC (mg/Kg) (wet wt)	Initial Moisture (%)	Adjusted Moisture ¹ (%)
0	06/04/07	WH	-	Lab Control	7.2	5526	19.2	25.5
			001	2B-SS04	8.4	1737	20.3	31.6
			002	2B-SS05	8.4	250	19.3	26.0
			003	2B-SS04-01	8.3	691	30.2	-
			004	2B-SS10	8.0	308	13.0	31.4
			005	2B-SS13	8.5	1710	29.2	-
			006	2B-SS14	8.1	806	18.9	25.8
			007	2B-SS31	7.7	238	11.5	49.6
			008	2B-SS33	7.8	298	19.5	28.0
			009	2B-SS34	7.8	613	22.5	27.4
			010	2B-SS41	7.9	997	11.4	26.8
			011	2B-SS44	7.2	528	9.6	26.2
			012	2B-SS49	7.2	1354	19.0	25.4
			013	2B-REF-SS01-01	7.6	925	20.4	25.1
			014	2B-REF-SS04	8.7	2025	22.4	29.8
			015	2B-REF-SS05	8.5	2979	13.2	25.4

¹ Initial soil moistures below 25% were rehydrated with dechlorinated lab water for test setup, targeting 25% - 45%.

SOIL CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Eisenia fetida*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	pH (su)	TOC (mg/Kg) (wet wt)	Final Moisture (%)
28	07/02/07	WH	-	Lab Control	7.8	528	21.6
			001	2B-SS04	8.3	893	24.7
			002	2B-SS05	8.4	265	16.0
			003	2B-SS04-01	8.2	817	24.9
			004	2B-SS10	7.9	188	34.4
			005	2B-SS13	9.1	498	27.4
			006	2B-SS14	8.5	957	22.6
			007	2B-SS31	8.1	209	26.1
			008	2B-SS33	8.2	293	26.1
			009	2B-SS34	8.5	259	23.4
			010	2B-SS41	8.5	220	20.1
			011	2B-SS44	8.6	25	19.4
			012	2B-SS49	8.9	509	20.8
			013	2B-REF-SS01-01	9.1	412	17.7
			014	2B-REF-SS04	8.9	541	24.7
			015	2B-REF-SS05	8.6	593	22.9

EXPOSURE ROOM PARAMETERS

CH2M06-00146 (SWMU 2)

Test Species: *Eisenia fetida*

Study Day	Study Date	Tech Initials	Room Temperature (°C)	Light Intensity (lux)
0	06/04/07	MB	25.0	553
1	06/05/07	MB	25.0	546
2	06/06/07	MB	25.0	564
3	06/07/07	WH	25.0	552
4	06/08/07	WH	25.0	555
5	06/09/07	DF	25.0	557
6	06/10/07	DF	25.0	563
7	06/11/07	RR	25.0	570
8	06/12/07	RR	25.0	638
9	06/13/07	RR	24.0	556
10	06/14/07	RR	25.0	562
11	06/15/07	RR	25.0	567
12	06/16/07	RR	25.0	582
13	06/17/07	DF	25.0	593
14	06/18/07	RR	25.0	561
15	06/19/07	WH	25.0	580
16	06/20/07	WH	25.0	506
17	06/21/07	WH	25.0	515
18	06/22/07	WH	25.0	509
19	06/23/07	WH	25.0	645
20	06/24/07	WH	25.0	631
21	06/25/07	WH	25.0	651
22	06/26/07	WH	25.0	647
23	06/27/07	WH	25.0	634
24	06/28/07	WH	25.0	629
25	06/29/07	WH	25.0	626
26	06/30/07	WH	25.0	631
27	07/01/07	WH	25.0	622
28	07/02/07	WH	25.0	570

ATTACHMENTS:

3. *Leptocheirus plumulosus* Toxicity Test

Endpoint Data

Statistics

Wet Chemistry

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species *Leptocheirus plumulosus*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight						Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Mean Repro/ Worm SEM
-	Day 0 Baseline	1	20	-	-	-	1.1095	1.1104	0.0009	0.0450	0.0367	0.006	-	-	-	-
-		2	20	-	-	-	1.1107	1.1112	0.0005	0.0250			-	-	-	-
-		3	20	-	-	-	1.117	1.1178	0.0008	0.0400			-	-	-	-
-	Lab Ctl	A	19	5.0	3.13	1.62	1.1130	1.1150	0.0020	0.1053	0.1059	0.005	12	0.632	0.591	0.034
-	Lab Ctl	B	20	0.0			1.1140	1.1159	0.0019	0.0950			13	0.650		
-	Lab Ctl	C	20	0.0			1.1098	1.1120	0.0022	0.1100			15	0.750		
-	Lab Ctl	D	18	10.0			1.1165	1.1181	0.0016	0.0889			10	0.556		
-	Lab Ctl	E	18	10.0			1.1132	1.1156	0.0024	0.1333			8	0.444		
-	Lab Ctl	F	20	0.0			1.1158	1.1177	0.0019	0.0950			13	0.650		
-	Lab Ctl	G	20	0.0			1.1124	1.1147	0.0023	0.1150			11	0.550		
-	Lab Ctl	H	20	0.0			1.1163	1.1184	0.0021	0.1050			10	0.500		
016	2B-EWSD-04	A	0	100.0	80.00	4.12	-	-	-	-	0.0536	0.006	0	-	0.442	0.169
016	2B-EWSD-04	B	7	65.0			1.1157	1.1162	0.0005	0.0714			3	0.429		
016	2B-EWSD-04	C	4	80.0			1.1086	1.1088	0.0002	0.0500			2	0.500		
016	2B-EWSD-04	D	3	85.0			1.1165	1.1166	0.0001	0.0333			4	1.333		
016	2B-EWSD-04	E	6	70.0			1.1139	1.1143	0.0004	0.0667			0	0.000		
016	2B-EWSD-04	F ¹	2	90.0			-	-	-	-			0	0.000		
016	2B-EWSD-04	G	6	70.0			1.1210	1.1213	0.0003	0.0500			2	0.333		
016	2B-EWSD-04	H	4	80.0			1.1169	1.1171	0.0002	0.0500			2	0.500		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species *Leptocheirus plumulosus*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight						Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Mean Repro/ Worm SEM
017	2B-EWSD-09	A	0	100.0	99.38	0.63	-	-	-	-	-	-	0	-	0.000	0.000
017	2B-EWSD-09	B	0	100.0			-	-	-	-			0	-		
017	2B-EWSD-09	C ¹	1	95.0			-	-	-	-			0	0.000		
017	2B-EWSD-09	D	0	100.0			-	-	-	-			0	-		
017	2B-EWSD-09	E	0	100.0			-	-	-	-			0	-		
017	2B-EWSD-09	F	0	100.0			-	-	-	-			0	-		
017	2B-EWSD-09	G	0	100.0			-	-	-	-			0	-		
017	2B-EWSD-09	H	0	100.0			-	-	-	-			0	-		
018	2B-EWSD-12	A	0	100.0	96.88	1.32	-	-	-	-	-	-	0	-	0.000	0.000
018	2B-EWSD-12	B	0	100.0			-	-	-	-			0	-		
018	2B-EWSD-12	C ¹	1	95.0			-	-	-	-			0	0.000		
018	2B-EWSD-12	D ¹	1	95.0			-	-	-	-			0	0.000		
018	2B-EWSD-12	E ¹	2	90.0			-	-	-	-			0	0.000		
018	2B-EWSD-12	F	0	100.0			-	-	-	-			0	-		
018	2B-EWSD-12	G	0	100.0			-	-	-	-			0	-		
018	2B-EWSD-12	H ¹	1	95.0			-	-	-	-			0	0.000		
														-		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species *Leptocheirus plumulosus*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight						Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Mean Repro/ Worm SEM
019	2B-EWSD-15	A	0	100.0	97.50	1.34	-	-	-	-	-	-	0	-	0.000	0.000
019	2B-EWSD-15	B	0	100.0			-	-	-	-			0	-		
019	2B-EWSD-15	C	0	100.0			-	-	-	-			0	-		
019	2B-EWSD-15	D ¹	2	90.0			-	-	-	-			0	0.000		
019	2B-EWSD-15	E	0	100.0			-	-	-	-			0	-		
019	2B-EWSD-15	F ¹	1	95.0			-	-	-	-			0	0.000		
019	2B-EWSD-15	G ¹	1	95.0			-	-	-	-			0	0.000		
019	2B-EWSD-15	H	0	100.0			-	-	-	-			0	-		
020	2B-EWSD-16	A	3	85.0	90.63	2.20	1.1148	1.1150	0.0002	0.0667	0.0708	0.004	5	1.667	0.810	0.296
020	2B-EWSD-16	B ¹	2	90.0			-	-	-	-			3	1.500		
020	2B-EWSD-16	C ¹	1	95.0			-	-	-	-			0	0.000		
020	2B-EWSD-16	D ¹	1	95.0			-	-	-	-			0	0.000		
020	2B-EWSD-16	E	4	80.0			1.1119	1.1122	0.0003	0.0750			4	1.000		
020	2B-EWSD-16	F ¹	2	90.0			-	-	-	-			0	0.000		
020	2B-EWSD-16	G	0	100.0			-	-	-	-			0	-		
020	2B-EWSD-16	H ¹	2	90.0			-	-	-	-			3	1.500		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species *Leptocheirus plumulosus*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight						Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Mean Repro/ Worm SEM
021	2B-EWSD-18	A	0	100.0	100.00	0.00	-	-	-	-	-	-	0	-	-	-
021	2B-EWSD-18	B	0	100.0			-	-	-	-			0	-		
021	2B-EWSD-18	C	0	100.0			-	-	-	-			0	-		
021	2B-EWSD-18	D	0	100.0			-	-	-	-			0	-		
021	2B-EWSD-18	E	0	100.0			-	-	-	-			0	-		
021	2B-EWSD-18	F	0	100.0			-	-	-	-			0	-		
021	2B-EWSD-18	G	0	100.0			-	-	-	-			0	-		
021	2B-EWSD-18	H	0	100.0			-	-	-	-			0	-		
022	2B-EWSD-20	A ¹	2	90.0	92.50	2.67	-	-	-	-	0.0417	0.008	0	0.000	0.417	0.271
022	2B-EWSD-20	B	4	80.0			1.1157	1.1159	0.0002	0.0500			3	0.750		
022	2B-EWSD-20	C	3	85.0			1.1169	1.1170	0.0001	0.0333			4	1.333		
022	2B-EWSD-20	D	0	100.0			-	-	-	-			0	-		
022	2B-EWSD-20	E ¹	1	95.0			-	-	-	-			0	0.000		
022	2B-EWSD-20	F	0	100.0			-	-	-	-			0	-		
022	2B-EWSD-20	G	0	100.0			-	-	-	-			0	-		
022	2B-EWSD-20	H ¹	2	90.0			-	-	-	-			0	0.000		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species *Leptocheirus plumulosus*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight						Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish/ Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Mean Repro/ Worm SEM
023	2B-EWSD-24	A	0	100.0	100.00	0.00	-	-	-	-	-	-	0	-	-	-
023	2B-EWSD-24	B	0	100.0			-	-	-	-			0	-		
023	2B-EWSD-24	C	0	100.0			-	-	-	-			0	-		
023	2B-EWSD-24	D	0	100.0			-	-	-	-			0	-		
023	2B-EWSD-24	E	0	100.0			-	-	-	-			0	-		
023	2B-EWSD-24	F	0	100.0			-	-	-	-			0	-		
023	2B-EWSD-24	G	0	100.0			-	-	-	-			0	-		
023	2B-EWSD-24	H	0	100.0			-	-	-	-			0	-		
024	2B-REF-EWSD-01	A	18	10.0	6.25	2.27	1.1161	1.1178	0.0017	0.0944	0.1047	0.004	10	0.556	0.653	0.050
024	2B-REF-EWSD-01	B	17	15.0			1.1250	1.1265	0.0015	0.0882			13	0.765		
024	2B-REF-EWSD-01	C	20	0.0			1.1187	1.1210	0.0023	0.1150			15	0.750		
024	2B-REF-EWSD-01	D	20	0.0			1.1163	1.1187	0.0024	0.1200			17	0.850		
024	2B-REF-EWSD-01	E	19	5.0			1.1052	1.1072	0.0020	0.1053			12	0.632		
024	2B-REF-EWSD-01	F	17	15.0			1.1113	1.1129	0.0016	0.0941			10	0.588		
024	2B-REF-EWSD-01	G	20	0.0			1.1162	1.1184	0.0022	0.1100			8	0.400		
024	2B-REF-EWSD-01	H	19	5.0			1.1146	1.1167	0.0021	0.1105			13	0.684		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species *Leptocheirus plumulosus*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight						Reproduction			
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM	Day 28 Repro Count (n)	Repro/ Worm/ Replicate (n)	Mean Repro/ Worm (n)	Mean Repro/ Worm SEM
025	2B-REF-EWSD-02	A	19	5.0	6.25	3.24	1.1140	1.1165	0.0025	0.1316	0.1280	0.006	17	0.895	0.912	0.055
025	2B-REF-EWSD-02	B	15	25.0			1.1135	1.1150	0.0015	0.1000			16	1.067		
025	2B-REF-EWSD-02	C	20	0.0			1.1050	1.1076	0.0026	0.1300			20	1.000		
025	2B-REF-EWSD-02	D	20	0.0			1.1060	1.1089	0.0029	0.1450			18	0.900		
025	2B-REF-EWSD-02	E	20	0.0			1.1159	1.1186	0.0027	0.1350			19	0.950		
025	2B-REF-EWSD-02	F	17	15.0			1.1163	1.1182	0.0019	0.1118			11	0.647		
025	2B-REF-EWSD-02	G	19	5.0			1.1048	1.1071	0.0023	0.1211			14	0.737		
025	2B-REF-EWSD-02	H	20	0.0			1.1253	1.1283	0.0030	0.1500			22	1.100		

¹ Survivor mass not sufficient to weigh.

Figure 1
CH2M06-00146 (SWMU 2)
28-d Soil Toxicity Test with *Leptocheirus plumulosus*

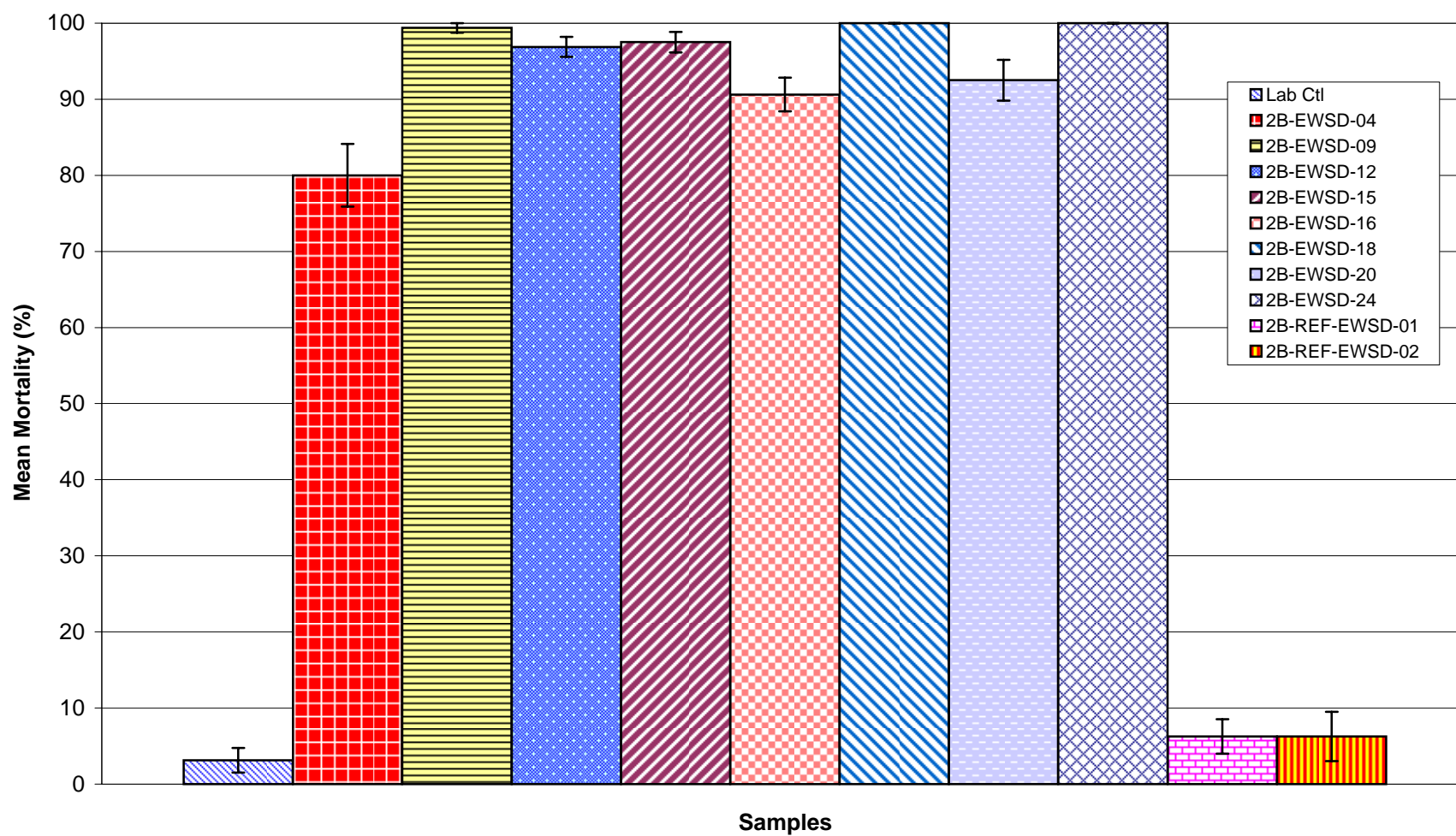


Figure 2
CH2M06-00146 (SWMU 2)
28-d Soil Toxicity Test with *Leptocheirus plumulosus*

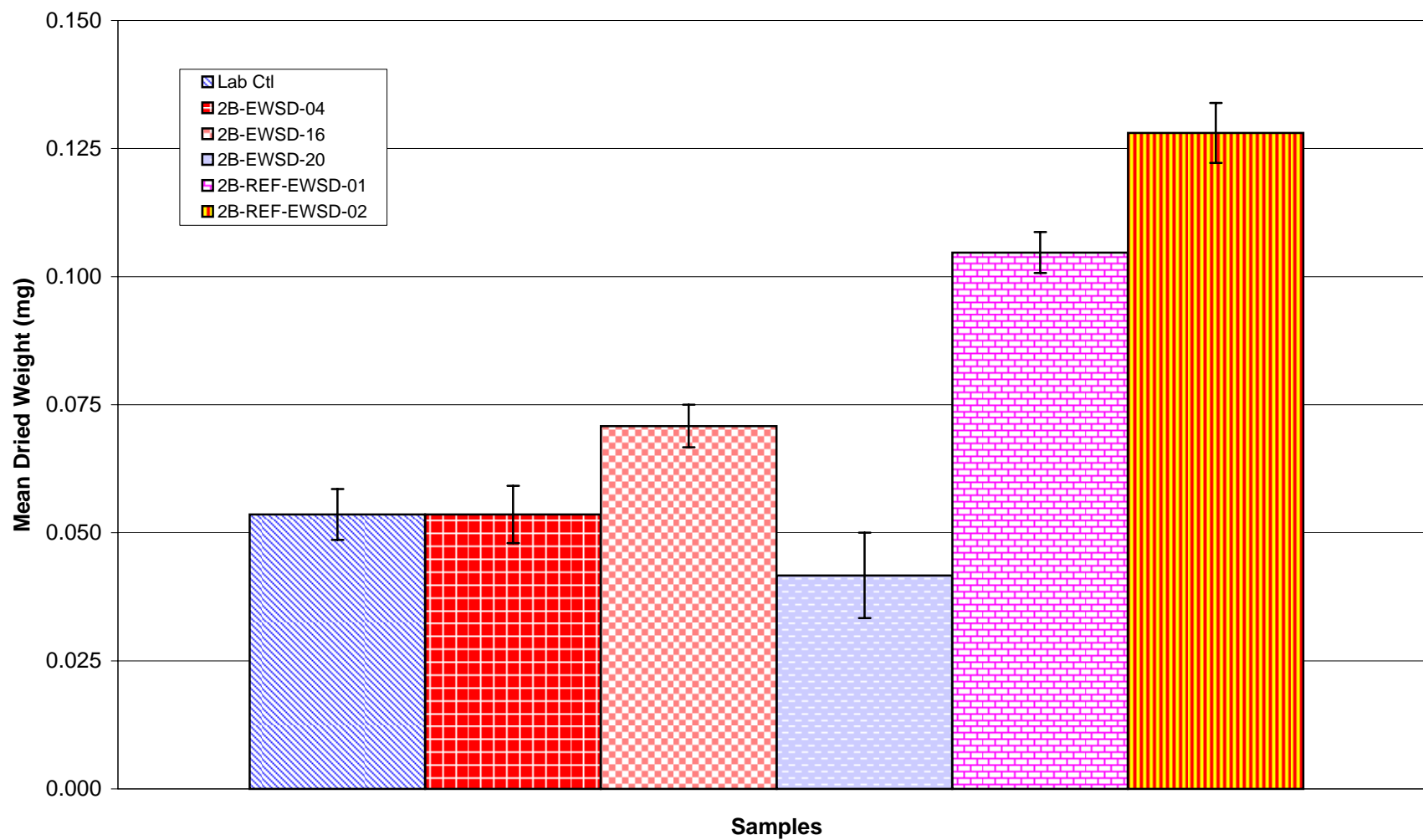
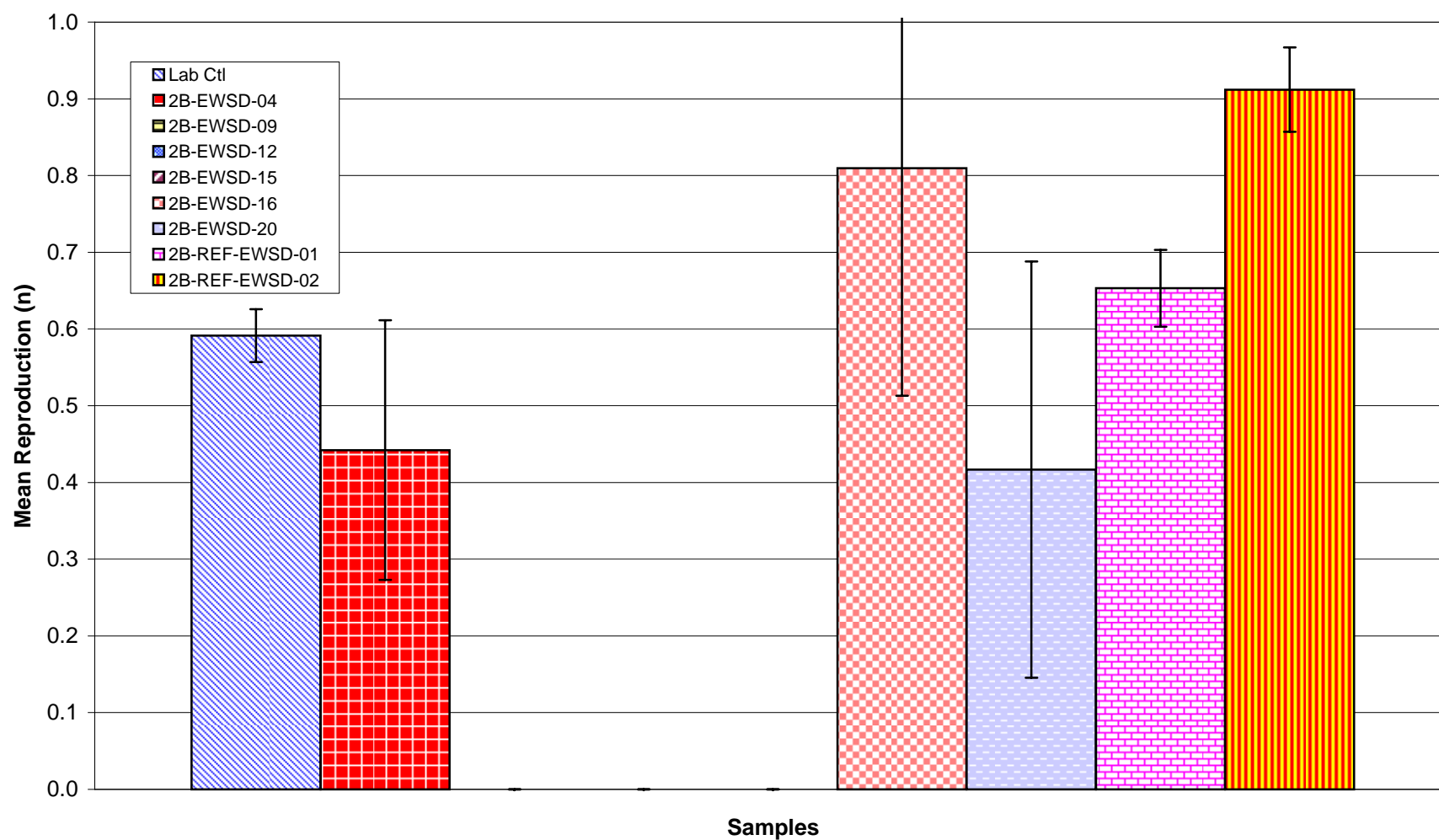


Figure 3
CH2M06-00146 (SWMU 2)
28-d Soil Toxicity Test with *Leptocheirus plumulosus*



Descriptive Statistics:

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
LabCtl	8	0	0.0313	0.0458	0.0162	0.0383
2B-REF01	8	0	0.0625	0.0641	0.0227	0.0536
2B-REF02	8	0	0.0625	0.0916	0.0324	0.0766
2B-SD04	8	0	0.8	0.116	0.0412	0.0974
2B-SD09	8	0	0.994	0.0177	0.00625	0.0148
2B-SD12	8	0	0.969	0.0372	0.0132	0.0311
2B-SD15	8	0	0.975	0.0378	0.0134	0.0316
2B-SD16	8	0	0.906	0.0623	0.022	0.0521
2B-SD18	8	0	1	0	0	0
2B-SD20	8	0	0.925	0.0756	0.0267	0.0632
2B-SD24	8	0	1	0	0	0

Column	Range	Max	Min	Median	5%	95%
LabCtl	0.1	0.1	0	0	0	0.1
2B-REF01	0.15	0.15	0	0.05	0	0.15
2B-REF02	0.25	0.25	0	0.025	0	0.25
2B-SD04	0.35	1	0.65	0.8	0.65	1
2B-SD09	0.05	1	0.95	1	0.95	1
2B-SD12	0.1	1	0.9	0.975	0.9	1
2B-SD15	0.1	1	0.9	1	0.9	1
2B-SD16	0.2	1	0.8	0.9	0.8	1
2B-SD18	0	1	1	1	1	1
2B-SD20	0.2	1	0.8	0.925	0.8	1
2B-SD24	0	1	1	1	1	1

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
LabCtl	0.999	-1.039	0.377	0.001	0.25	0.0225
2B-REF01	0.475	-1.546	0.21	0.348	0.5	0.06
2B-REF02	1.556	1.699	0.304	0.028	0.5	0.09
2B-SD04	0.452	-0.409	0.18	0.548	6.4	5.215
2B-SD09	-2.828	8	0.513	<0.001	7.95	7.902
2B-SD12	-0.824	-0.152	0.3	0.033	7.75	7.518
2B-SD15	-1.323	0.875	0.371	0.002	7.8	7.615
2B-SD16	-0.304	0.146	0.21	0.35	7.25	6.598
2B-SD18	0	-2.8	0	<0.001	8	8
2B-SD20	-0.496	-0.995	0.214	0.323	7.4	6.885
2B-SD24	0	-2.8	0	<0.001	8	8

One Way Analysis of Variance**Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_Leptocheirus plumulosus****Normality Test:** Failed (P = 0.015)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks**Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_Leptocheirus plumulosus**

Group	N	Missing	Median	25%	75%
asinsqrt-LabCtl	8	0	0	0	0.274
asinsqrt-REF01	8	0	0.226	0	0.36
asinsqrt-REF02	8	0	0.113	0	0.312
asinsqrt-SD04	8	0	1.107	0.991	1.211
asinsqrt-SD09	8	0	1.571	1.571	1.571
asinsqrt-SD12	8	0	1.458	1.345	1.571
asinsqrt-SD15	8	0	1.571	1.345	1.571
asinsqrt-SD16	8	0	1.249	1.211	1.345
asinsqrt-SD18	8	0	1.571	1.571	1.571
asinsqrt-SD20	8	0	1.297	1.211	1.571
asinsqrt-SD24	8	0	1.571	1.571	1.571

H = 72.267 with 10 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SD18 vs asinsqrt-LabCtl	59.313	4.643	Yes
asinsqrt-SD24 vs asinsqrt-LabCtl	59.313	4.643	Yes
asinsqrt-SD09 vs asinsqrt-LabCtl	56.438	4.418	Yes
asinsqrt-SD15 vs asinsqrt-LabCtl	49.625	3.885	Yes
asinsqrt-SD12 vs asinsqrt-LabCtl	46.75	3.66	Yes
asinsqrt-SD20 vs asinsqrt-LabCtl	38.875	3.043	Yes
asinsqrt-SD16 vs asinsqrt-LabCtl	32.063	2.51	No
asinsqrt-SD04 vs asinsqrt-LabCtl	24.125	1.889	Do Not Test
asinsqrt-REF01 vs asinsqrt-LabCtl	3.375	0.264	Do Not Test
asinsqrt-REF02 vs asinsqrt-LabCtl	2.063	0.161	Do Not Test

One Way Analysis of VarianceData source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Normality Test: Failed (P = 0.003)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on RanksData source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Group	N	Missing	Median	25%	75%
asinsqrt-REF01	8	0	0.226	0	0.36
asinsqrt-REF02	8	0	0.113	0	0.312
asinsqrt-SD04	8	0	1.107	0.991	1.211
asinsqrt-SD09	8	0	1.571	1.571	1.571
asinsqrt-SD12	8	0	1.458	1.345	1.571
asinsqrt-SD15	8	0	1.571	1.345	1.571
asinsqrt-SD16	8	0	1.249	1.211	1.345
asinsqrt-SD18	8	0	1.571	1.571	1.571
asinsqrt-SD20	8	0	1.297	1.211	1.571
asinsqrt-SD24	8	0	1.571	1.571	1.571

H = 62.059 with 9 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SD18 vs asinsqrt-REF01	53.125	4.572	Yes
asinsqrt-SD24 vs asinsqrt-REF01	53.125	4.572	Yes
asinsqrt-SD09 vs asinsqrt-REF01	50.25	4.325	Yes
asinsqrt-SD15 vs asinsqrt-REF01	43.438	3.739	Yes
asinsqrt-SD12 vs asinsqrt-REF01	40.563	3.491	Yes
asinsqrt-SD20 vs asinsqrt-REF01	32.688	2.813	Yes
asinsqrt-SD16 vs asinsqrt-REF01	25.875	2.227	No
asinsqrt-SD04 vs asinsqrt-REF01	17.938	1.544	Do Not Test
asinsqrt-REF02 vs asinsqrt-REF01	0.75	0.0645	Do Not Test

One Way Analysis of Variance

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Normality Test: Failed (P = 0.003)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Group	N	Missing	Median	25%	75%
asinsqrt-REF01	8	0	0.226	0	0.36
asinsqrt-REF02	8	0	0.113	0	0.312
asinsqrt-SD04	8	0	1.107	0.991	1.211
asinsqrt-SD09	8	0	1.571	1.571	1.571
asinsqrt-SD12	8	0	1.458	1.345	1.571
asinsqrt-SD15	8	0	1.571	1.345	1.571
asinsqrt-SD16	8	0	1.249	1.211	1.345
asinsqrt-SD18	8	0	1.571	1.571	1.571
asinsqrt-SD20	8	0	1.297	1.211	1.571
asinsqrt-SD24	8	0	1.571	1.571	1.571

H = 62.059 with 9 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
asinsqrt-SD18 vs asinsqrt-REF02	53.875	4.637	Yes
asinsqrt-SD24 vs asinsqrt-REF02	53.875	4.637	Yes
asinsqrt-SD09 vs asinsqrt-REF02	51	4.389	Yes
asinsqrt-SD15 vs asinsqrt-REF02	44.188	3.803	Yes
asinsqrt-SD12 vs asinsqrt-REF02	41.313	3.556	Yes
asinsqrt-SD20 vs asinsqrt-REF02	33.438	2.878	Yes
asinsqrt-SD16 vs asinsqrt-REF02	26.625	2.292	No
asinsqrt-SD04 vs asinsqrt-REF02	18.688	1.608	Do Not Test
asinsqrt-REF01 vs asinsqrt-REF02	0.75	0.0645	Do Not Test

Descriptive Statistics:

Data source: Data_Dried Weight (mg) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean	% Dried Weight Compared to:		
							LabCtl	2B-REF01	2B-REF02
LabCtl	8	0	0.106	0.014	0.00496	0.0117	-		
2B-REF01	8	0	0.105	0.0113	0.00399	0.00944	99.06	-	82.03
2B-REF02	8	0	0.128	0.0166	0.00588	0.0139	120.75	121.90	-
2B-SD04	6	0	0.0536	0.0137	0.0056	0.0144	50.57	51.05	41.88
2B-SD16	2	0	0.0708	0.00587	0.00415	0.0527	66.79	67.43	55.31
2B-SD20	2	0	0.0417	0.0118	0.00835	0.106	39.34	39.71	32.58

Column	Range	Max	Min	Median	5%	95%
LabCtl	0.0444	0.133	0.0889	0.105	0.0889	0.133
2B-REF01	0.0318	0.12	0.0882	0.108	0.0882	0.12
2B-REF02	0.05	0.15	0.1	0.131	0.1	0.15
2B-SD04	0.0381	0.0714	0.0333	0.05	0.0333	0.0714
2B-SD16	0.0083	0.075	0.0667	0.0708	0.0667	0.075
2B-SD20	0.0167	0.05	0.0333	0.0417	0.0333	0.05

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
LabCtl	0.947	1.119	0.157	0.685	0.847	0.0912
2B-REF01	-0.228	-1.405	0.194	0.454	0.837	0.0886
2B-REF02	-0.454	-0.364	0.171	0.601	1.025	0.133
2B-SD04	-0.061	-0.299	0.269	0.188	0.321	0.0182
2B-SD16	--	--	0.26	0.481	0.142	0.0101
2B-SD20	--	--	0.26	0.481	0.0833	0.00361

One Way Analysis of Variance

Data source: Data_Dried Weight (mg) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.894)

Group Name	N	Missing	Mean	Std Dev	SEM
LabCtl	8	0	0.106	0.014	0.00496
2B-REF01	8	0	0.105	0.0113	0.00399
2B-REF02	8	0	0.128	0.0166	0.00588
2B-SD04	6	0	0.0536	0.0137	0.0056
2B-SD16	2	0	0.0708	0.00587	0.00415
2B-SD20	2	0	0.0417	0.0118	0.00835

Source of Variation	DF	SS	MS	F	P
Between Groups	5	0.0276	0.00552	29.059	<0.001
Residual	28	0.00532	0.00019		
Total	33	0.0329			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
LabCtl vs. 2B-SD20	0.0643	5.901	<0.001	Yes
LabCtl vs. 2B-SD04	0.0524	7.037	<0.001	Yes
LabCtl vs. 2B-SD16	0.0351	3.221	0.016	Yes
LabCtl vs. 2B-REF02	0.0221	3.211	0.017	Yes
LabCtl vs. 2B-REF01	0.00125	0.181	1	No

One Way Analysis of Variance

Data source: Data_Dried Weight (mg) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.796)

Group Name	N	Missing	Mean	Std Dev	SEM
2B-REF01	8	0	0.105	0.0113	0.00399
2B-REF02	8	0	0.128	0.0166	0.00588
2B-SD04	6	0	0.0536	0.0137	0.0056
2B-SD16	2	0	0.0708	0.00587	0.00415
2B-SD20	2	0	0.0417	0.0118	0.00835

Source of Variation	DF	SS	MS	F	P
Between Groups	4	0.0265	0.00663	35.33	<0.001
Residual	21	0.00394	0.000188		
Total	25	0.0304			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
2B-REF01 vs. 2B-SD20	0.063	5.822	<0.001	Yes
2B-REF01 vs. 2B-SD04	0.0511	6.911	<0.001	Yes
2B-REF01 vs. 2B-SD16	0.0338	3.125	0.02	Yes
2B-REF01 vs. 2B-REF02	0.0234	3.413	0.01	Yes

One Way Analysis of Variance

Data source: Data_Dried Weight (mg) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.796)

Group Name	N	Missing	Mean	Std Dev	SEM
2B-REF01	8	0	0.105	0.0113	0.00399
2B-REF02	8	0	0.128	0.0166	0.00588
2B-SD04	6	0	0.0536	0.0137	0.0056
2B-SD16	2	0	0.0708	0.00587	0.00415
2B-SD20	2	0	0.0417	0.0118	0.00835

Source of Variation	DF	SS	MS	F	P
Between Groups	4	0.0265	0.00663	35.33	<0.001
Residual	21	0.00394	0.000188		
Total	25	0.0304			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
2B-REF02 vs. 2B-SD20	0.0864	7.981	<0.001	Yes
2B-REF02 vs. 2B-SD04	0.0745	10.071	<0.001	Yes
2B-REF02 vs. 2B-SD16	0.0572	5.284	<0.001	Yes
2B-REF02 vs. 2B-REF01	0.0234	3.413	0.01	Yes

Descriptive Statistics:

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean	% Reproduction Compared to:		
							LabCtl	2B-REF01	2B-REF02
LabCtl	8	0	0.592	0.0976	0.0345	0.0816	-		
2B-REF01	8	0	0.653	0.141	0.05	0.118	110.30	-	71.60
2B-REF02	8	0	0.912	0.156	0.0551	0.13	154.05	139.66	-
2B-SD04	7	0	0.442	0.448	0.169	0.414	74.66	67.69	48.46
2B-SD09	1	0	0	--	--	--	0.00	0.00	0.00
2B-SD12	4	0	0	0	0	0	0.00	0.00	0.00
2B-SD15	3	0	0	0	0	0	0.00	0.00	0.00
2B-SD16	7	0	0.81	0.784	0.296	0.725	136.82	124.04	88.82
2B-SD20	5	0	0.417	0.607	0.271	0.753	70.44	63.86	45.72

Column	Range	Max	Min	Median	5%	95%
LabCtl	0.306	0.75	0.444	0.594	0.444	0.75
2B-REF01	0.45	0.85	0.4	0.658	0.4	0.85
2B-REF02	0.453	1.1	0.647	0.925	0.647	1.1
2B-SD04	1.333	1.333	0	0.429	0	1.333
2B-SD09	0	0	0	0	0	0
2B-SD12	0	0	0	0	0	0
2B-SD15	0	0	0	0	0	0
2B-SD16	1.667	1.667	0	1	0	1.667
2B-SD20	1.333	1.333	0	0	0	1.333

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
LabCtl	0.0732	-0.351	0.161	0.664	4.732	2.866
2B-REF01	-0.503	0.223	0.128	0.791	5.225	3.552
2B-REF02	-0.649	-0.382	0.207	0.372	7.296	6.824
2B-SD04	1.385	2.795	0.306	0.047	3.095	2.572
2B-SD09	--	--	--	--	0	0
2B-SD12	0	-6	0	<0.001	0	0
2B-SD15	0.00E+00	--	0	<0.001	0	0
2B-SD16	-0.143	-2.582	0.278	0.106	5.667	8.279
2B-SD20	1.101	-0.538	0.354	0.04	2.083	2.339

One Way Analysis of Variance

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_Leptocheirus plumulosus

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_Leptocheirus plumulosus

Group	N	Missing	Median	25%	75%
LabCtl	8	0	0.594	0.525	0.65
2B-REF01	8	0	0.658	0.572	0.758
2B-REF02	8	0	0.925	0.816	1.034
2B-SD04	7	0	0.429	0.0833	0.5
2B-SD09	1	0	0	0	0
2B-SD12	4	0	0	0	0
2B-SD15	3	0	0	0	0
2B-SD16	7	0	1	0	1.5
2B-SD20	5	0	0	0	0.896

H = 22.102 with 8 degrees of freedom. (P = 0.005)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.005)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
2B-SD15 vs LabCtl	18.875	1.875	No
2B-SD12 vs LabCtl	18.875	2.073	Do Not Test
2B-SD09 vs LabCtl	18.875	1.197	Do Not Test
2B-REF02 vs LabCtl	12.813	1.724	Do Not Test
2B-SD04 vs LabCtl	6.732	0.875	Do Not Test
2B-SD20 vs LabCtl	5.575	0.658	Do Not Test
2B-SD16 vs LabCtl	3.911	0.508	Do Not Test
2B-REF01 vs LabCtl	3.25	0.437	Do Not Test

One Way Analysis of Variance

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_*Leptocheirus plumulosus*

Group	N	Missing	Median	25%	75%
2B-REF01	8	0	0.658	0.572	0.758
2B-REF02	8	0	0.925	0.816	1.034
2B-SD04	7	0	0.429	0.0833	0.5
2B-SD09	1	0	0	0	0
2B-SD12	4	0	0	0	0
2B-SD15	3	0	0	0	0
2B-SD16	7	0	1	0	1.5
2B-SD20	5	0	0	0	0.896

H = 18.257 with 7 degrees of freedom. (P = 0.011)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.011)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
2B-SD09 vs 2B-REF01	16.813	1.262	No
2B-SD12 vs 2B-REF01	16.813	2.186	Do Not Test
2B-SD15 vs 2B-REF01	16.813	1.978	Do Not Test
2B-REF02 vs 2B-REF01	7.375	1.175	Do Not Test
2B-SD20 vs 2B-REF01	6.613	0.924	Do Not Test
2B-SD04 vs 2B-REF01	6.241	0.96	Do Not Test
2B-SD16 vs 2B-REF01	1.402	0.216	Do Not Test

One Way Analysis of Variance

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_ *Leptocheirus plumulosus*

Normality Test: Failed (P = <0.001)

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Data source: Data_Reproduction (n) in CH2M01-00146 (SWMU 2)_ *Leptocheirus plumulosus*

Group	N	Missing	Median	25%	75%
2B-REF01	8	0	0.658	0.572	0.758
2B-REF02	8	0	0.925	0.816	1.034
2B-SD04	7	0	0.429	0.0833	0.5
2B-SD09	1	0	0	0	0
2B-SD12	4	0	0	0	0
2B-SD15	3	0	0	0	0
2B-SD16	7	0	1	0	1.5
2B-SD20	5	0	0	0	0.896

H = 18.257 with 7 degrees of freedom. (P = 0.011)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.011)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
2B-SD09 vs 2B-REF02	24.188	1.816	No
2B-SD12 vs 2B-REF02	24.188	3.146	Do Not Test
2B-SD15 vs 2B-REF02	24.188	2.845	Do Not Test
2B-SD20 vs 2B-REF02	13.988	1.954	Do Not Test
2B-SD04 vs 2B-REF02	13.616	2.095	Do Not Test
2B-REF01 vs 2B-REF02	7.375	1.175	Do Not Test
2B-SD16 vs 2B-REF02	5.973	0.919	Do Not Test

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Leptocheirus plumulosus*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
0	05/31/07	DF/WH	-	Lab Control	23.0	5.1	7.3	28.3	0.30	<0.01
			016	2B-EWSD-04	23.0	4.9	7.6	30.7	0.40	<0.01
			017	2B-EWSD-09	23.0	4.7	7.8	30.9	0.40	<0.01
			018	2B-EWSD-12	23.0	4.3	7.8	30.9	0.95	0.03
			019	2B-EWSD-15	23.0	5.2	7.9	31.1	0.50	0.02
			020	2B-EWSD-16	23.0	5.5	7.9	30.4	0.55	<0.01
			021	2B-EWSD-18	23.0	5.4	8.0	30.3	0.55	<0.01
			022	2B-EWSD-20	23.0	5.2	8.0	30.9	0.70	<0.01
			023	2B-EWSD-24	23.0	4.7	8.0	30.2	0.70	<0.01
			024	2B-REF-EWSD-01	23.0	5.3	7.6	32.4	1.15	0.01
			025	2B-REF-EWSD-02	23.0	5.1	7.6	31.7	2.90	0.02
1	06/01/07	DF	-	Lab Control	23.0	6.2				
			016	2B-EWSD-04	23.0	5.6				
			017	2B-EWSD-09	23.0	5.2				
			018	2B-EWSD-12	23.0	5.3				
			019	2B-EWSD-15	23.0	5.8				
			020	2B-EWSD-16	23.0	5.4				
			021	2B-EWSD-18	23.0	6.1				
			022	2B-EWSD-20	23.0	4.9				
			023	2B-EWSD-24	23.0	5.3				
			024	2B-REF-EWSD-01	23.0	6.0				
			025	2B-REF-EWSD-02	23.0	6.2				
2	06/02/07	DF	-	Lab Control	23.0	7.0				
			016	2B-EWSD-04	23.0	7.5				
			017	2B-EWSD-09	23.0	7.6				
			018	2B-EWSD-12	23.0	6.0				
			019	2B-EWSD-15	23.0	6.4				
			020	2B-EWSD-16	23.0	7.0				
			021	2B-EWSD-18	23.0	7.0				
			022	2B-EWSD-20	23.0	7.4				
			023	2B-EWSD-24	23.0	6.8				
			024	2B-REF-EWSD-01	23.0	6.3				
			025	2B-REF-EWSD-02	23.0	5.9				
3	06/03/07	MB	-	Lab Control	24.0	5.6				
			016	2B-EWSD-04	24.0	5.4				
			017	2B-EWSD-09	24.0	5.4				
			018	2B-EWSD-12	24.0	5.5				
			019	2B-EWSD-15	24.0	6.0				
			020	2B-EWSD-16	24.0	5.7				
			021	2B-EWSD-18	24.0	5.6				
			022	2B-EWSD-20	24.0	5.6				
			023	2B-EWSD-24	24.0	5.7				
			024	2B-REF-EWSD-01	24.0	5.5				
			025	2B-REF-EWSD-02	24.0	5.7				

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Leptocheirus plumulosus*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
4	06/04/07	DF	-	Lab Control	24.0	5.2	7.9	28.5	0.25	<0.01
			016	2B-EWSD-04	24.0	5.1	7.7	30.7	0.50	<0.01
			017	2B-EWSD-09	24.0	5.0	7.8	30.7	0.60	0.01
			018	2B-EWSD-12	24.0	5.3	7.9	31.0	0.55	0.02
			019	2B-EWSD-15	24.0	5.8	7.8	31.2	0.70	0.02
			020	2B-EWSD-16	24.0	5.3	7.7	30.6	0.75	<0.01
			021	2B-EWSD-18	24.0	5.2	7.6	30.5	0.45	0.01
			022	2B-EWSD-20	24.0	5.3	7.8	31.1	0.90	0.01
			023	2B-EWSD-24	24.0	5.5	7.8	30.4	0.85	0.02
			024	2B-REF-EWSD-01	24.0	5.1	7.6	31.8	2.15	0.01
			025	2B-REF-EWSD-02	24.0	5.5	7.5	31.7	1.95	0.01
5	06/05/07	DF	-	Lab Control	24.0	5.9				
			016	2B-EWSD-04	24.0	6.0				
			017	2B-EWSD-09	24.0	5.8				
			018	2B-EWSD-12	24.0	5.9				
			019	2B-EWSD-15	24.0	5.5				
			020	2B-EWSD-16	24.0	5.7				
			021	2B-EWSD-18	24.0	5.8				
			022	2B-EWSD-20	24.0	5.7				
			023	2B-EWSD-24	24.0	6.0				
			024	2B-REF-EWSD-01	24.0	5.8				
			025	2B-REF-EWSD-02	24.0	5.9				
6	06/06/07	DF	-	Lab Control	24.0	6.3	8.0	28.5	0.45	<0.01
			016	2B-EWSD-04	24.0	6.0	7.7	30.6	0.65	<0.01
			017	2B-EWSD-09	24.0	5.7	7.9	30.8	0.70	<0.01
			018	2B-EWSD-12	24.0	5.8	7.6	31.1	0.50	0.01
			019	2B-EWSD-15	24.0	5.6	7.4	31.3	0.80	0.01
			020	2B-EWSD-16	24.0	5.7	7.5	30.7	0.50	<0.01
			021	2B-EWSD-18	24.0	5.9	7.7	27.2	0.70	<0.01
			022	2B-EWSD-20	24.0	5.4	7.8	31.1	0.75	<0.01
			023	2B-EWSD-24	24.0	6.0	7.8	30.6	0.90	<0.01
			024	2B-REF-EWSD-01	24.0	5.1	7.5	31.7	0.75	0.01
			025	2B-REF-EWSD-02	24.0	5.3	7.6	31.6	2.05	0.01
7	06/07/07	DF	-	Lab Control	24.0	5.8				
			016	2B-EWSD-04	24.0	5.9				
			017	2B-EWSD-09	24.0	5.7				
			018	2B-EWSD-12	24.0	5.6				
			019	2B-EWSD-15	24.0	5.3				
			020	2B-EWSD-16	24.0	6.0				
			021	2B-EWSD-18	24.0	5.7				
			022	2B-EWSD-20	24.0	5.9				
			023	2B-EWSD-24	24.0	5.6				
			024	2B-REF-EWSD-01	24.0	5.2				
			025	2B-REF-EWSD-02	24.0	5.1				

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Leptocheirus plumulosus*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
8	06/08/07	DF	-	Lab Control	24.0	6.0	7.9	28.7	0.50	<0.01
			016	2B-EWSD-04	24.0	6.2	7.8	30.4	0.55	<0.01
			017	2B-EWSD-09	24.0	6.3	7.8	30.7	0.50	<0.01
			018	2B-EWSD-12	24.0	5.9	7.8	31.0	0.25	0.01
			019	2B-EWSD-15	24.0	6.0	7.5	31.3	0.61	0.02
			020	2B-EWSD-16	24.0	5.7	7.6	30.9	0.45	<0.01
			021	2B-EWSD-18	24.0	5.6	7.7	30.6	0.75	<0.01
			022	2B-EWSD-20	24.0	5.8	7.9	31.2	0.85	0.03
			023	2B-EWSD-24	24.0	5.3	7.9	30.7	1.00	0.01
			024	2B-REF-EWSD-01	24.0	5.5	7.5	31.5	1.90	0.01
			025	2B-REF-EWSD-02	24.0	5.1	7.4	31.5	2.00	0.02
9	06/09/07	DF	-	Lab Control	24.0	5.7				
			016	2B-EWSD-04	24.0	5.6				
			017	2B-EWSD-09	24.0	5.8				
			018	2B-EWSD-12	24.0	5.4				
			019	2B-EWSD-15	24.0	5.5				
			020	2B-EWSD-16	24.0	5.7				
			021	2B-EWSD-18	24.0	5.8				
			022	2B-EWSD-20	24.0	5.7				
			023	2B-EWSD-24	24.0	6.3				
			024	2B-REF-EWSD-01	24.0	5.3				
			025	2B-REF-EWSD-02	24.0	5.2				
10	06/10/07	DF	-	Lab Control	24.0	5.7				
			016	2B-EWSD-04	24.0	5.4				
			017	2B-EWSD-09	24.0	5.4				
			018	2B-EWSD-12	24.0	5.5				
			019	2B-EWSD-15	24.0	5.3				
			020	2B-EWSD-16	24.0	5.2				
			021	2B-EWSD-18	24.0	5.5				
			022	2B-EWSD-20	24.0	5.5				
			023	2B-EWSD-24	24.0	5.1				
			024	2B-REF-EWSD-01	24.0	5.1				
			025	2B-REF-EWSD-02	24.0	5.0				
11	06/11/07	DF	-	Lab Control	24.0	5.9	7.8	28.9		
			016	2B-EWSD-04	24.0	5.8	7.5	30.7		
			017	2B-EWSD-09	24.0	5.7	7.4	31.0		
			018	2B-EWSD-12	24.0	5.4	7.7	31.1		
			019	2B-EWSD-15	24.0	5.6	7.6	31.5		
			020	2B-EWSD-16	24.0	6.3	7.3	30.9		
			021	2B-EWSD-18	24.0	6.2	7.5	30.8		
			022	2B-EWSD-20	24.0	5.8	7.6	31.4		
			023	2B-EWSD-24	24.0	6.0	7.4	30.9		
			024	2B-REF-EWSD-01	24.0	5.8	7.2	31.7		
			025	2B-REF-EWSD-02	24.0	5.5	7.4	31.7		

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Leptocheirus plumulosus*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
12	06/12/07	DF	-	Lab Control	23.5	6.0				
			016	2B-EWSD-04	23.5	5.7				
			017	2B-EWSD-09	23.5	5.3				
			018	2B-EWSD-12	23.5	5.5				
			019	2B-EWSD-15	23.5	5.2				
			020	2B-EWSD-16	23.5	5.0				
			021	2B-EWSD-18	23.5	5.2				
			022	2B-EWSD-20	23.5	5.1				
			023	2B-EWSD-24	23.5	5.4				
			024	2B-REF-EWSD-01	23.5	5.1				
			025	2B-REF-EWSD-02	23.5	5.0				
13	06/13/07	DF	-	Lab Control	23.5	5.3	7.4	29.6	0.55	<0.01
			016	2B-EWSD-04	23.5	5.5	7.3	31.1	0.60	<0.01
			017	2B-EWSD-09	23.5	5.4	7.5	31.2	0.40	0.01
			018	2B-EWSD-12	23.5	5.2	7.3	31.2	0.50	<0.01
			019	2B-EWSD-15	23.5	5.0	7.5	31.7	0.75	<0.01
			020	2B-EWSD-16	23.5	5.2	7.3	30.9	0.65	<0.01
			021	2B-EWSD-18	23.5	5.3	7.2	31.1	0.55	0.01
			022	2B-EWSD-20	23.5	5.5	7.1	30.7	0.70	<0.01
			023	2B-EWSD-24	23.5	5.7	7.6	31.0	1.25	0.01
			024	2B-REF-EWSD-01	23.5	5.2	7.7	31.5	2.00	0.02
			025	2B-REF-EWSD-02	23.5	5.1	7.8	31.6	1.68	0.01
14	06/14/07	DF	-	Lab Control	23.0	5.7				
			016	2B-EWSD-04	23.0	5.3				
			017	2B-EWSD-09	23.0	5.5				
			018	2B-EWSD-12	23.0	5.4				
			019	2B-EWSD-15	23.0	5.6				
			020	2B-EWSD-16	23.0	5.2				
			021	2B-EWSD-18	23.0	5.3				
			022	2B-EWSD-20	23.0	5.5				
			023	2B-EWSD-24	23.0	5.8				
			024	2B-REF-EWSD-01	23.0	5.6				
			025	2B-REF-EWSD-02	23.0	5.8				
15	06/15/07	DF	-	Lab Control	23.0	5.8	7.5	29.7		
			016	2B-EWSD-04	23.0	5.9	7.4	30.2		
			017	2B-EWSD-09	23.0	6.1	7.6	30.4		
			018	2B-EWSD-12	23.0	5.7	7.3	30.7		
			019	2B-EWSD-15	23.0	5.6	7.5	31.3		
			020	2B-EWSD-16	23.0	5.3	7.2	31.2		
			021	2B-EWSD-18	23.0	5.0	7.1	30.9		
			022	2B-EWSD-20	23.0	5.4	7.5	31.1		
			023	2B-EWSD-24	23.0	5.5	7.6	30.9		
			024	2B-REF-EWSD-01	23.0	5.1	7.8	31.1		
			025	2B-REF-EWSD-02	23.0	5.3	7.8	31.3		

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Leptocheirus plumulosus*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
16	06/16/07	DF	-	Lab Control	23.0	5.7				
			016	2B-EWSD-04	23.0	5.8				
			017	2B-EWSD-09	23.0	5.3				
			018	2B-EWSD-12	23.0	5.5				
			019	2B-EWSD-15	23.0	5.7				
			020	2B-EWSD-16	23.0	5.4				
			021	2B-EWSD-18	23.0	5.5				
			022	2B-EWSD-20	23.0	5.8				
			023	2B-EWSD-24	23.0	6.1				
			024	2B-REF-EWSD-01	23.0	5.3				
			025	2B-REF-EWSD-02	23.0	5.4				
17	06/17/07	DF	-	Lab Control	22.5	5.5				
			016	2B-EWSD-04	22.5	5.5				
			017	2B-EWSD-09	22.5	5.6				
			018	2B-EWSD-12	22.5	5.4				
			019	2B-EWSD-15	22.5	5.7				
			020	2B-EWSD-16	22.5	5.9				
			021	2B-EWSD-18	22.5	5.8				
			022	2B-EWSD-20	22.5	5.8				
			023	2B-EWSD-24	22.5	5.6				
			024	2B-REF-EWSD-01	22.5	5.5				
			025	2B-REF-EWSD-02	22.5	5.3				
18	06/18/07	DF	-	Lab Control	23.0	5.8	7.6	29.8		
			016	2B-EWSD-04	23.0	5.9	7.5	30.9		
			017	2B-EWSD-09	23.0	6.1	7.5	31.1		
			018	2B-EWSD-12	23.0	6.1	7.7	31.4		
			019	2B-EWSD-15	23.0	5.8	7.3	31.7		
			020	2B-EWSD-16	23.0	5.6	7.4	31.3		
			021	2B-EWSD-18	23.0	5.4	7.3	31.5		
			022	2B-EWSD-20	23.0	5.7	7.1	31.1		
			023	2B-EWSD-24	23.0	5.7	7.5	30.9		
			024	2B-REF-EWSD-01	23.0	5.7	7.4	30.9		
			025	2B-REF-EWSD-02	23.0	5.5	7.2	31.3		
19	06/19/07	DF	-	Lab Control	23.0	5.7				
			016	2B-EWSD-04	23.0	5.6				
			017	2B-EWSD-09	23.0	5.3				
			018	2B-EWSD-12	23.0	5.8				
			019	2B-EWSD-15	23.0	5.5				
			020	2B-EWSD-16	23.0	5.7				
			021	2B-EWSD-18	23.0	5.4				
			022	2B-EWSD-20	23.0	5.5				
			023	2B-EWSD-24	23.0	5.5				
			024	2B-REF-EWSD-01	23.0	5.3				
			025	2B-REF-EWSD-02	23.0	5.4				

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Leptocheirus plumulosus*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
20	06/20/07	DF	-	Lab Control	23.0	5.6	7.5	29.8	0.65	<0.01
			016	2B-EWSD-04	23.0	5.5	7.4	31.1	0.50	<0.01
			017	2B-EWSD-09	23.0	5.2	7.7	30.9	0.60	0.01
			018	2B-EWSD-12	23.0	5.5	7.6	31.0	0.75	0.01
			019	2B-EWSD-15	23.0	5.8	7.8	31.4	0.80	<0.01
			020	2B-EWSD-16	23.0	5.7	7.7	31.6	0.50	<0.01
			021	2B-EWSD-18	23.0	5.7	7.9	31.1	0.55	0.01
			022	2B-EWSD-20	23.0	5.8	7.7	30.9	0.90	0.01
			023	2B-EWSD-24	23.0	5.9	7.5	30.7	0.80	<0.01
			024	2B-REF-EWSD-01	23.0	5.3	7.4	31.4	1.05	0.02
			025	2B-REF-EWSD-02	23.0	5.3	7.3	31.5	1.25	0.02
21	06/21/07	DF	-	Lab Control	23.0	5.7				
			016	2B-EWSD-04	23.0	5.5				
			017	2B-EWSD-09	23.0	5.6				
			018	2B-EWSD-12	23.0	5.4				
			019	2B-EWSD-15	23.0	5.7				
			020	2B-EWSD-16	23.0	5.3				
			021	2B-EWSD-18	23.0	5.5				
			022	2B-EWSD-20	23.0	5.6				
			023	2B-EWSD-24	23.0	5.1				
			024	2B-REF-EWSD-01	23.0	5.3				
			025	2B-REF-EWSD-02	23.0	5.2				
22	06/22/07	DF	-	Lab Control	23.0	5.9	7.6	29.8		
			016	2B-EWSD-04	23.0	5.6	7.5	30.8		
			017	2B-EWSD-09	23.0	5.7	7.8	30.9		
			018	2B-EWSD-12	23.0	5.3	7.6	31.0		
			019	2B-EWSD-15	23.0	5.5	7.6	31.4		
			020	2B-EWSD-16	23.0	5.5	7.6	30.9		
			021	2B-EWSD-18	23.0	5.4	7.4	30.9		
			022	2B-EWSD-20	23.0	5.7	7.7	31.1		
			023	2B-EWSD-24	23.0	5.3	7.3	31.3		
			024	2B-REF-EWSD-01	23.0	5.4	7.1	31.4		
			025	2B-REF-EWSD-02	23.0	5.3	7.0	31.5		
23	06/23/07	WH	-	Lab Control	23.0	5.8				
			016	2B-EWSD-04	23.0	5.5				
			017	2B-EWSD-09	23.0	5.7				
			018	2B-EWSD-12	23.0	5.2				
			019	2B-EWSD-15	23.0	5.6				
			020	2B-EWSD-16	23.0	5.6				
			021	2B-EWSD-18	23.0	5.3				
			022	2B-EWSD-20	23.0	5.8				
			023	2B-EWSD-24	23.0	5.1				
			024	2B-REF-EWSD-01	23.0	5.3				
			025	2B-REF-EWSD-02	23.0	5.3				

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Leptocheirus plumulosus*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
24	06/24/07	WH	-	Lab Control	23.0	5.7				
			016	2B-EWSD-04	23.0	5.5				
			017	2B-EWSD-09	23.0	5.8				
			018	2B-EWSD-12	23.0	5.2				
			019	2B-EWSD-15	23.0	5.4				
			020	2B-EWSD-16	23.0	5.5				
			021	2B-EWSD-18	23.0	5.4				
			022	2B-EWSD-20	23.0	5.7				
			023	2B-EWSD-24	23.0	5.3				
			024	2B-REF-EWSD-01	23.0	5.3				
			025	2B-REF-EWSD-02	23.0	5.5				
25	06/25/07	WH	-	Lab Control	23.0	5.8	7.6	29.7		
			016	2B-EWSD-04	23.0	5.6	7.7	31.0		
			017	2B-EWSD-09	23.0	5.8	7.6	31.1		
			018	2B-EWSD-12	23.0	5.3	7.4	31.3		
			019	2B-EWSD-15	23.0	5.4	7.7	30.9		
			020	2B-EWSD-16	23.0	5.5	7.2	31.3		
			021	2B-EWSD-18	23.0	5.5	7.7	31.3		
			022	2B-EWSD-20	23.0	5.6	7.9	30.8		
			023	2B-EWSD-24	23.0	5.1	7.8	31.0		
			024	2B-REF-EWSD-01	23.0	5.2	7.5	31.1		
			025	2B-REF-EWSD-02	23.0	5.4	7.1	31.3		
26	06/26/07	WH	-	Lab Control	23.0	5.7				
			016	2B-EWSD-04	23.0	5.4				
			017	2B-EWSD-09	23.0	5.8				
			018	2B-EWSD-12	23.0	5.2				
			019	2B-EWSD-15	23.0	5.5				
			020	2B-EWSD-16	23.0	5.7				
			021	2B-EWSD-18	23.0	5.5				
			022	2B-EWSD-20	23.0	5.8				
			023	2B-EWSD-24	23.0	5.3				
			024	2B-REF-EWSD-01	23.0	5.2				
			025	2B-REF-EWSD-02	23.0	5.4				
27	06/27/07	WH	-	Lab Control	23.0	6.8				
			016	2B-EWSD-04	23.0	6.6				
			017	2B-EWSD-09	23.0	7.1				
			018	2B-EWSD-12	23.0	5.8				
			019	2B-EWSD-15	23.0	5.7				
			020	2B-EWSD-16	23.0	6.9				
			021	2B-EWSD-18	23.0	5.2				
			022	2B-EWSD-20	23.0	6.2				
			023	2B-EWSD-24	23.0	6.6				
			024	2B-REF-EWSD-01	23.0	5.8				
			025	2B-REF-EWSD-02	23.0	4.5				

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Leptocheirus plumulosus*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
28	06/28/07	WH	-	Lab Control	23.0	6.4	7.7	29.8	0.55	<0.01
			016	2B-EWSD-04	23.0	7.0	7.9	31.5	0.25	<0.01
			017	2B-EWSD-09	23.0	7.6	8.0	31.1	0.1	0.01
			018	2B-EWSD-12	23.0	6.5	8.0	31.1	0.8	0.02
			019	2B-EWSD-15	23.0	6.2	8.0	31.7	6.95	<0.01
			020	2B-EWSD-16	23.0	7.4	8.1	31.1	0.15	0.01
			021	2B-EWSD-18	23.0	6.2	7.9	31.3	0.6	<0.01
			022	2B-EWSD-20	23.0	6.9	8.0	31.4	0.2	0.01
			023	2B-EWSD-24	23.0	7.4	8.0	31.3	0.3	<0.01
			024	2B-REF-EWSD-01	23.0	7.4	8.0	31.5	4.15	0.07
			025	2B-REF-EWSD-02	23.0	7.3	6.5	31.7	6.88	0.03

PORE WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Leptocheirus plumulosus*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	pH	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
-1	05/30/07	WH/RR	016	2B-EWSD-04	7.5	43.1	0.65	0.08
			017	2B-EWSD-09	No initial pore water- Dry sediment			
			018	2B-EWSD-12	7.7	36.9	0.50	0.11
			019	2B-EWSD-15	7.8	54.2	0.80	1.11
			020	2B-EWSD-16	No initial pore water- Dry sediment			
			021	2B-EWSD-18	No initial pore water- Sediment consistency of putty			
			022	2B-EWSD-20	7.9	39.9	0.75	0.12
			023	2B-EWSD-24	No initial pore water- Dry sediment			
			024	2B-REF-EWSD-01	7.7	57.5	0.75	0.10
			025	2B-REF-EWSD-02	7.0	52.5	2.08	0.06
28	06/28/07	WH	-	Lab Control	7.4	42.4	0.15	<0.01
			016	2B-EWSD-04	7.4	47.0	0.40	<0.01
			017	2B-EWSD-09	7.4	45.5	1.20	<0.01
			018	2B-EWSD-12	7.5	47.1	0.60	<0.01
			019	2B-EWSD-15	7.6	55.4	2.90	<0.01
			020	2B-EWSD-16	7.8	48.1	1.10	<0.01
			021	2B-EWSD-18	7.8	48.0	1.40	<0.01
			022	2B-EWSD-20	7.8	43.9	0.45	<0.01
			023	2B-EWSD-24	7.8	42.1	0.40	<0.01
			024	2B-REF-EWSD-01	7.9	45.8	5.05	<0.01
			025	2B-REF-EWSD-02	6.5	49.7	8.40	<0.01

ATTACHMENTS:

4. *Neanthes arenaceodentata* Toxicity Test

Endpoint Data

Statistics

Wet Chemistry

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight					
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM
-	Day 0 Baseline	1	12	-	-	-	1.1134	1.1153	0.0019	0.1583	0.1542	0.004
-		2	14	-	-	-	1.0888	1.0909	0.0021	0.1500		
-	Lab Ctl	A	8	20.0	17.50	2.50	1.1291	1.1322	0.0031	0.3875	2.1628	0.386
-	Lab Ctl	B	8	20.0			1.1060	1.1152	0.0092	1.1500		
-	Lab Ctl	C	8	20.0			1.1209	1.1330	0.0121	1.5125		
-	Lab Ctl	D	9	10.0			1.1035	1.1313	0.0278	3.0889		
-	Lab Ctl	E	8	20.0			1.1340	1.1525	0.0185	2.3125		
-	Lab Ctl	F	9	10.0			1.1248	1.1582	0.0334	3.7111		
-	Lab Ctl	G	7	30.0			1.1231	1.1429	0.0198	2.8286		
-	Lab Ctl	H	9	10.0			1.1064	1.1272	0.0208	2.3111		
016	2B-EWSD-04	A	8	20.0	15.00	5.67	1.1197	1.1604	0.0407	5.0875	5.5203	0.286
016	2B-EWSD-04	B	9	10.0			1.1022	1.1437	0.0415	4.6111		
016	2B-EWSD-04	C	5	50.0			1.1189	1.1430	0.0241	4.8200		
016	2B-EWSD-04	D	8	20.0			1.1118	1.1492	0.0374	4.6750		
016	2B-EWSD-04	E	9	10.0			1.1052	1.1593	0.0541	6.0111		
016	2B-EWSD-04	F	10	0.0			1.1037	1.1651	0.0614	6.1400		
016	2B-EWSD-04	G	9	10.0			1.1035	1.1636	0.0601	6.6778		
016	2B-EWSD-04	H	10	0.0			1.1017	1.1631	0.0614	6.1400		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight					
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM
017	2B-EWSD-09	A	4	60.0	73.75	5.32	1.1258	1.1345	0.0087	2.1750	3.8610	0.870
017	2B-EWSD-09	B	3	70.0			1.0890	1.0987	0.0097	3.2333		
017	2B-EWSD-09	C	1	90.0			1.0910	1.0957	0.0047	4.7000		
017	2B-EWSD-09	D	3	70.0			1.1320	1.1399	0.0079	2.6333		
017	2B-EWSD-09	E	3	70.0			1.1086	1.1157	0.0071	2.3667		
017	2B-EWSD-09	F	1	90.0			1.0951	1.1046	0.0095	9.5000		
017	2B-EWSD-09	G	1	90.0			1.1105	1.1146	0.0041	4.1000		
017	2B-EWSD-09	H	5	50.0			1.1076	1.1185	0.0109	2.1800		
018	2B-EWSD-12	A	9	10.0	16.25	4.98	1.1095	1.1459	0.0364	4.0444	3.9715	0.293
018	2B-EWSD-12	B	7	30.0			1.1023	1.1270	0.0247	3.5286		
018	2B-EWSD-12	C	6	40.0			1.1160	1.1325	0.0165	2.7500		
018	2B-EWSD-12	D	8	20.0			1.1107	1.1375	0.0268	3.3500		
018	2B-EWSD-12	E	10	0.0			1.1095	1.1554	0.0459	4.5900		
018	2B-EWSD-12	F	10	0.0			1.1084	1.1552	0.0468	4.6800		
018	2B-EWSD-12	G	8	20.0			1.1053	1.1474	0.0421	5.2625		
018	2B-EWSD-12	H	9	10.0			1.0820	1.1141	0.0321	3.5667		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight					
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM
019	2B-EWSD-15	A	5	50.0	10.00	6.27	1.1245	1.1396	0.0151	3.0200	6.4067	0.756
019	2B-EWSD-15	B	8	20.0			1.1310	1.1791	0.0481	6.0125		
019	2B-EWSD-15	C	10	0.0			1.1065	1.1550	0.0485	4.8500		
019	2B-EWSD-15	D	10	0.0			1.1201	1.1789	0.0588	5.8800		
019	2B-EWSD-15	E	9	10.0			1.1074	1.1966	0.0892	9.9111		
019	2B-EWSD-15	F	10	0.0			1.1104	1.1710	0.0606	6.0600		
019	2B-EWSD-15	G	10	0.0			1.0881	1.1567	0.0686	6.8600		
019	2B-EWSD-15	H	10	0.0			1.1215	1.2081	0.0866	8.6600		
020	2B-EWSD-16	A	7	30.0	20.00	5.35	1.1064	1.1341	0.0277	3.9571	4.7466	0.293
020	2B-EWSD-16	B	8	20.0			1.1077	1.1413	0.0336	4.2000		
020	2B-EWSD-16	C	6	40.0			1.1031	1.1277	0.0246	4.1000		
020	2B-EWSD-16	D	9	10.0			1.0983	1.1402	0.0419	4.6556		
020	2B-EWSD-16	E	7	30.0			1.0980	1.1391	0.0411	5.8714		
020	2B-EWSD-16	F	10	0.0			1.1036	1.1652	0.0616	6.1600		
020	2B-EWSD-16	G	7	30.0			1.1070	1.1401	0.0331	4.7286		
020	2B-EWSD-16	H	10	0.0			1.1260	1.1690	0.0430	4.3000		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight					
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM
021	2B-EWSD-18	A	9	10.0	6.25	1.83	1.0967	1.1310	0.0343	3.8111	5.3611	0.370
021	2B-EWSD-18	B	9	10.0			1.1112	1.1631	0.0519	5.7667		
021	2B-EWSD-18	C	10	0.0			1.1255	1.1711	0.0456	4.5600		
021	2B-EWSD-18	D	9	10.0			1.1175	1.1564	0.0389	4.3222		
021	2B-EWSD-18	E	10	0.0			1.0939	1.1549	0.0610	6.1000		
021	2B-EWSD-18	F	10	0.0			1.1255	1.1849	0.0594	5.9400		
021	2B-EWSD-18	G	9	10.0			1.0948	1.1438	0.0490	5.4444		
021	2B-EWSD-18	H	9	10.0			1.1091	1.1716	0.0625	6.9444		
022	2B-EWSD-20	A	3	70.0	46.25	4.60	1.0968	1.1076	0.0108	3.6000	3.4344	0.183
022	2B-EWSD-20	B	6	40.0			1.1108	1.1289	0.0181	3.0167		
022	2B-EWSD-20	C	7	30.0			1.1334	1.1583	0.0249	3.5571		
022	2B-EWSD-20	D	5	50.0			1.0884	1.1057	0.0173	3.4600		
022	2B-EWSD-20	E	6	40.0			1.1009	1.1233	0.0224	3.7333		
022	2B-EWSD-20	F	6	40.0			1.0998	1.1202	0.0204	3.4000		
022	2B-EWSD-20	G	6	40.0			1.1145	1.1399	0.0254	4.2333		
022	2B-EWSD-20	H	4	60.0			1.1010	1.1109	0.0099	2.4750		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

FEL Sample No.	Sample ID	Rep	Mortality				Dried Weight					
			Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM
023	2B-EWSD-24	A	6	40.0	50.00	5.00	1.1129	1.1385	0.0256	4.2667	6.0443	0.455
023	2B-EWSD-24	B	4	60.0			1.1081	1.1247	0.0166	4.1500		
023	2B-EWSD-24	C	5	50.0			1.1055	1.1400	0.0345	6.9000		
023	2B-EWSD-24	D	4	60.0			1.1011	1.1268	0.0257	6.4250		
023	2B-EWSD-24	E	8	20.0			1.1094	1.1653	0.0559	6.9875		
023	2B-EWSD-24	F	4	60.0			1.1008	1.1220	0.0212	5.3000		
023	2B-EWSD-24	G	5	50.0			1.1219	1.1574	0.0355	7.1000		
023	2B-EWSD-24	H	4	60.0			1.0828	1.1117	0.0289	7.2250		
024	2B-REF-EWSD-01	A	6	40.0	26.25	7.78	1.0934	1.1278	0.0344	5.7333	4.7170	0.432
024	2B-REF-EWSD-01	B	4	60.0			1.1152	1.1366	0.0214	5.3500		
024	2B-REF-EWSD-01	C	8	20.0			1.1127	1.1519	0.0392	4.9000		
024	2B-REF-EWSD-01	D	8	20.0			1.1169	1.1444	0.0275	3.4375		
024	2B-REF-EWSD-01	E	5	50.0			1.1053	1.1383	0.0330	6.6000		
024	2B-REF-EWSD-01	F	10	0.0			1.1085	1.1377	0.0292	2.9200		
024	2B-REF-EWSD-01	G	10	0.0			1.1043	1.1525	0.0482	4.8200		
024	2B-REF-EWSD-01	H	8	20.0			1.0868	1.1186	0.0318	3.9750		

Survival/Weight/Reproduction Data
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

Mortality							Dried Weight					
FEL Sample No.	Sample ID	Rep	Survival Count/ Replicate (n)	Mortality/ Replicate (%)	Mean Mortality/ Sample (%)	Mortality SEM	Dried Filter/Dish Tared Wt (g)	Dried Filter/Dish/ Organism Wt (g)	Dried Weight/ Replicate (g)	Dried Wt/ Organism/ Replicate (mg)	Mean Dried Wt/ Organism (mg)	Mean Dried Wt/ Organism SEM
025	2B-REF-EWSD-02	A	6	40.0	47.50	7.50	1.1367	1.1602	0.0235	3.9167	3.6856	0.163
025	2B-REF-EWSD-02	B	3	70.0			1.0857	1.0966	0.0109	3.6333		
025	2B-REF-EWSD-02	C	2	80.0			1.1074	1.1150	0.0076	3.8000		
025	2B-REF-EWSD-02	D	7	30.0			1.1234	1.1479	0.0245	3.5000		
025	2B-REF-EWSD-02	E	5	50.0			1.1192	1.1395	0.0203	4.0600		
025	2B-REF-EWSD-02	F	8	20.0			1.1514	1.1864	0.0350	4.3750		
025	2B-REF-EWSD-02	G	7	30.0			1.1374	1.1605	0.0231	3.3000		
025	2B-REF-EWSD-02	H	4	60.0			1.1456	1.1572	0.0116	2.9000		

Figure 1
CH2M06-00146 (SWMU 2)
28-d Soil Toxicity Test with *Neanthes arenaceodentata*

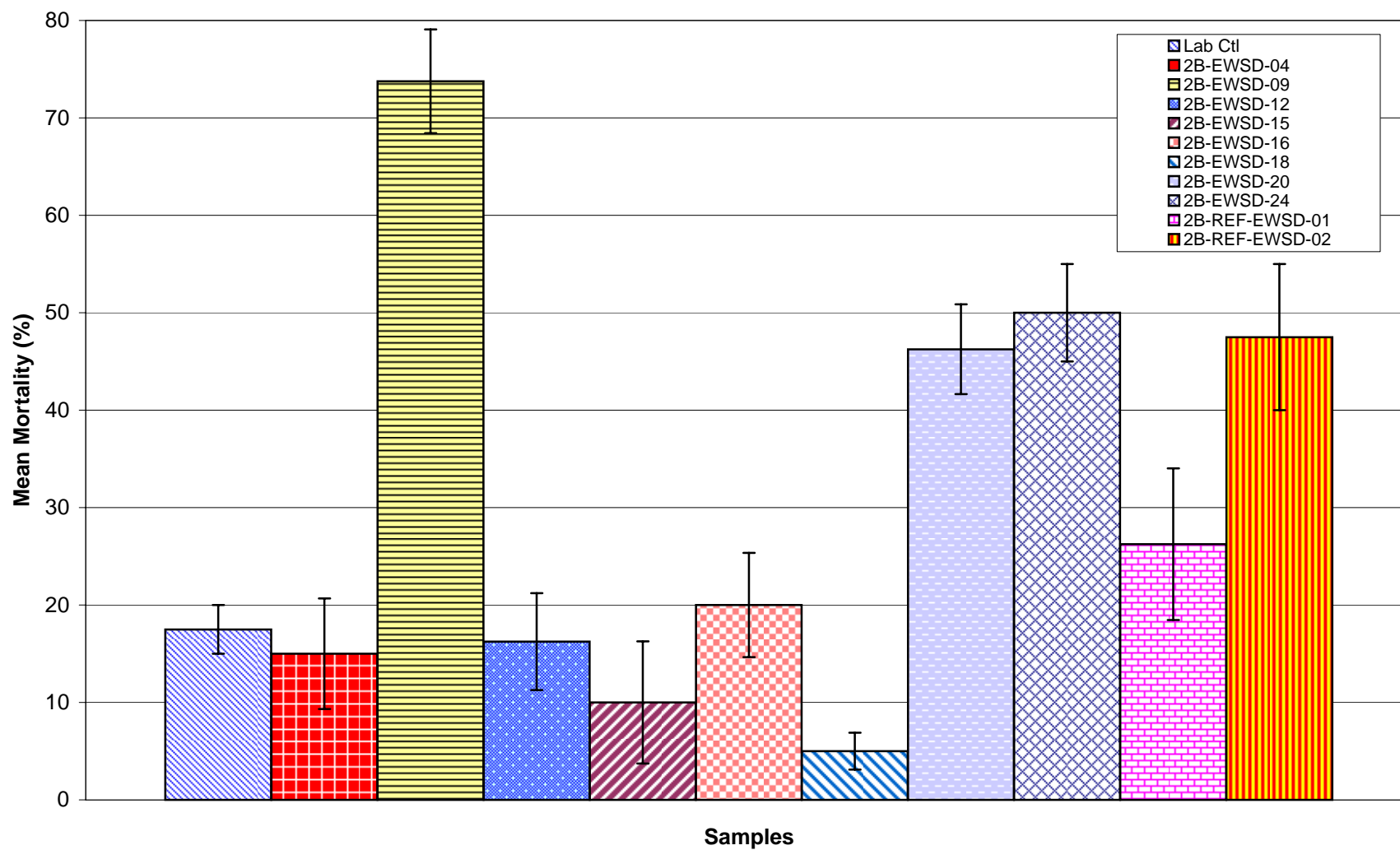
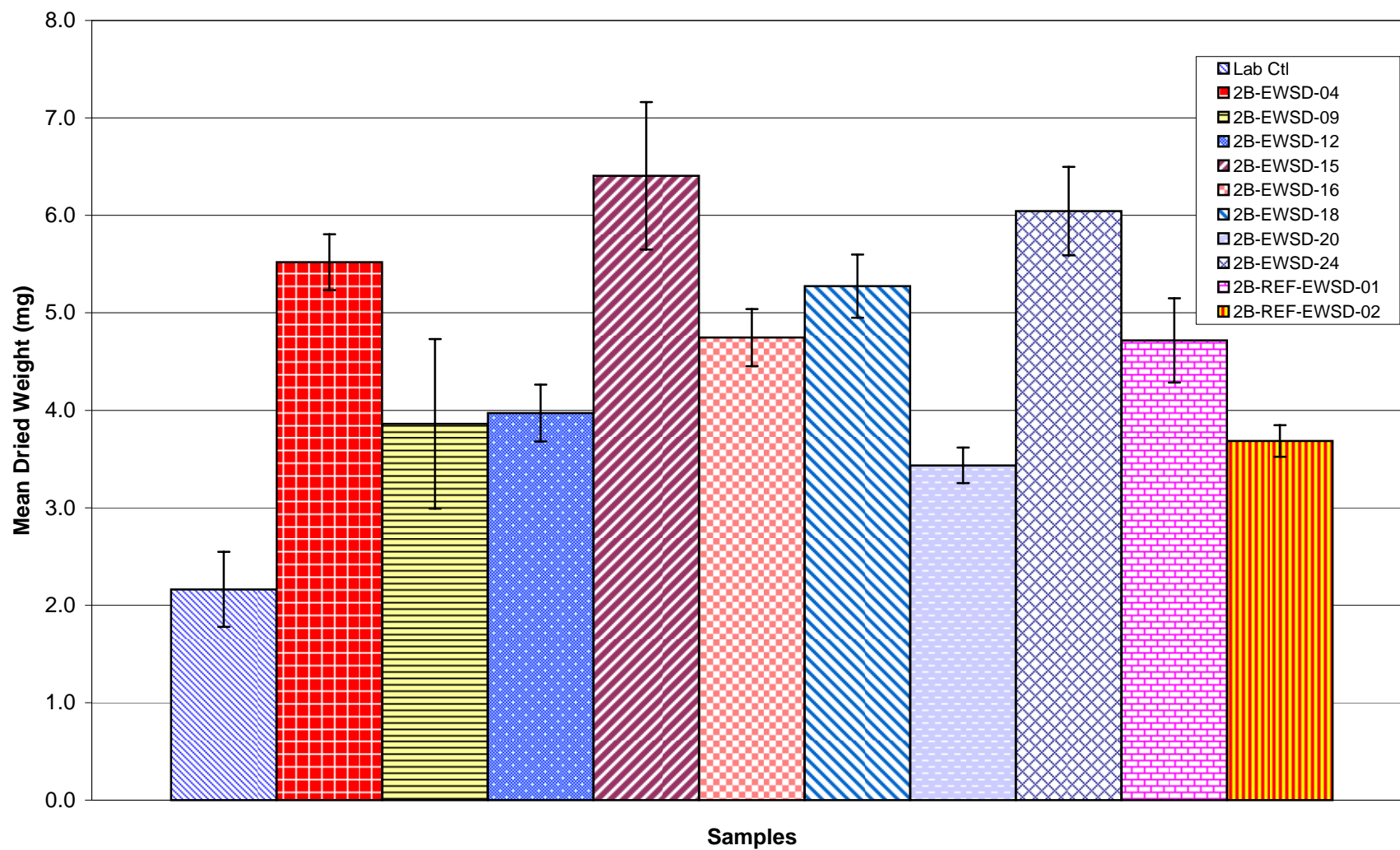


Figure 2
CH2M06-00146 (SWMU 2)
28-d Soil Toxicity Test with *Neanthes arenaceodentata*



Descriptive Statistics:

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Neanthes arenaceodentata*

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean
LabCtl	8	0	0.175	0.0707	0.025	0.0591
2B-REF01	8	0	0.263	0.22	0.0778	0.184
2B-REF02	8	0	0.475	0.212	0.075	0.177
2B-SD04	8	0	0.15	0.16	0.0567	0.134
2B-SD09	8	0	0.738	0.151	0.0532	0.126
2B-SD12	8	0	0.163	0.141	0.0498	0.118
2B-SD15	8	0	0.1	0.177	0.0627	0.148
2B-SD16	8	0	0.2	0.151	0.0535	0.126
2B-SD18	8	0	0.0625	0.0518	0.0183	0.0433
2B-SD20	8	0	0.45	0.12	0.0423	0.0999
2B-SD24	8	0	0.5	0.141	0.05	0.118

Column	Range	Max	Min	Median	5%	95%
LabCtl	0.2	0.3	0.1	0.2	0.1	0.3
2B-REF01	0.6	0.6	0	0.2	0	0.6
2B-REF02	0.6	0.8	0.2	0.45	0.2	0.8
2B-SD04	0.5	0.5	0	0.1	0	0.5
2B-SD09	0.4	0.9	0.5	0.7	0.5	0.9
2B-SD12	0.4	0.4	0	0.15	0	0.4
2B-SD15	0.5	0.5	0	0	0	0.5
2B-SD16	0.4	0.4	0	0.25	0	0.4
2B-SD18	0.1	0.1	0	0.1	0	0.1
2B-SD20	0.4	0.7	0.3	0.4	0.3	0.7
2B-SD24	0.4	0.6	0.2	0.55	0.2	0.6

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
LabCtl	0.404	-0.229	0.263	0.105	1.4	0.28
2B-REF01	0.314	-1.085	0.237	0.204	2.1	0.89
2B-REF02	0.314	-1.244	0.17	0.608	3.8	2.12
2B-SD04	1.663	3.422	0.253	0.139	1.2	0.36
2B-SD09	-0.183	-1.142	0.235	0.214	5.9	4.51
2B-SD12	0.48	-0.564	0.171	0.601	1.3	0.35
2B-SD15	2.051	4.194	0.339	0.007	0.8	0.3
2B-SD16	-0.331	-1.487	0.246	0.165	1.6	0.48
2B-SD18	-0.644	-2.24	0.391	<0.001	0.5	0.05
2B-SD20	1.339	2.576	0.287	0.051	3.6	1.72
2B-SD24	-1.616	2.471	0.26	0.114	4	2.14

One Way Analysis of Variance

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Neanthes arenaceodentata*

Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.552)

Group Name	N	Missing	Mean	Std Dev	SEM
asinsqrt-LabCtl	8	0	0.425	0.094	0.0332
asinsqrt-REF01	8	0	0.468	0.33	0.117
asinsqrt-REF02	8	0	0.76	0.223	0.0789
asinsqrt-SD04	8	0	0.335	0.257	0.0907
asinsqrt-SD09	8	0	1.049	0.18	0.0635
asinsqrt-SD12	8	0	0.354	0.25	0.0883
asinsqrt-SD15	8	0	0.196	0.299	0.106
asinsqrt-SD16	8	0	0.401	0.269	0.0952
asinsqrt-SD18	8	0	0.201	0.167	0.0589
asinsqrt-SD20	8	0	0.735	0.122	0.0433
asinsqrt-SD24	8	0	0.783	0.148	0.0525

Source of Variation	DF	SS	MS	F	P
Between Groups	10	5.974	0.597	11.843	<0.001
Residual	77	3.884	0.0504		
Total	87	9.857			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
asinsqrt-LabCtl vs. asinsqrt-SD09	0.624	5.558	<0.001	Yes
asinsqrt-LabCtl vs. asinsqrt-SD24	0.358	3.188	0.021	Yes
asinsqrt-LabCtl vs. asinsqrt-REF02	0.335	2.981	0.038	Yes
asinsqrt-LabCtl vs. asinsqrt-SD20	0.31	2.762	0.072	No
asinsqrt-LabCtl vs. asinsqrt-SD15	0.229	2.036	0.452	Do Not Test
asinsqrt-LabCtl vs. asinsqrt-SD18	0.224	1.993	0.498	Do Not Test
asinsqrt-LabCtl vs. asinsqrt-SD04	0.0902	0.803	1	Do Not Test
asinsqrt-LabCtl vs. asinsqrt-SD12	0.0705	0.628	1	Do Not Test
asinsqrt-LabCtl vs. asinsqrt-REF01	0.0435	0.387	1	Do Not Test
asinsqrt-LabCtl vs. asinsqrt-SD16	0.0238	0.212	1	Do Not Test

One Way Analysis of Variance

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Neanthes arenaceodentata*

Normality Test: Passed (P = 0.185)

Equal Variance Test: Passed (P = 0.731)

Group Name	N	Missing	Mean	Std Dev	SEM
asinsqrt-REF01	8	0	0.468	0.33	0.117
asinsqrt-REF02	8	0	0.76	0.223	0.0789
asinsqrt-SD04	8	0	0.335	0.257	0.0907
asinsqrt-SD09	8	0	1.049	0.18	0.0635
asinsqrt-SD12	8	0	0.354	0.25	0.0883
asinsqrt-SD15	8	0	0.196	0.299	0.106
asinsqrt-SD16	8	0	0.401	0.269	0.0952
asinsqrt-SD18	8	0	0.201	0.167	0.0589
asinsqrt-SD20	8	0	0.735	0.122	0.0433
asinsqrt-SD24	8	0	0.783	0.148	0.0525

Source of Variation	DF	SS	MS	F	P
Between Groups	9	5.896	0.655	11.998	<0.001
Residual	70	3.822	0.0546		
Total	79	9.718			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
asinsqrt-REF01 vs. asinsqrt-SD09	0.581	4.97	<0.001	Yes
asinsqrt-REF01 vs. asinsqrt-SD24	0.315	2.692	0.08	No
asinsqrt-REF01 vs. asinsqrt-REF02	0.291	2.493	0.135	Do Not Test
asinsqrt-REF01 vs. asinsqrt-SD15	0.272	2.328	0.205	Do Not Test
asinsqrt-REF01 vs. asinsqrt-SD18	0.267	2.288	0.227	Do Not Test
asinsqrt-REF01 vs. asinsqrt-SD20	0.267	2.282	0.23	Do Not Test
asinsqrt-REF01 vs. asinsqrt-SD04	0.134	1.144	1	Do Not Test
asinsqrt-REF01 vs. asinsqrt-SD12	0.114	0.976	1	Do Not Test
asinsqrt-REF01 vs. asinsqrt-SD16	0.0673	0.576	1	Do Not Test

One Way Analysis of Variance

Data source: Data_Mortality (%) in CH2M01-00146 (SWMU 2)_*Neanthes arenaceodentata*

Normality Test: Passed (P = 0.185)

Equal Variance Test: Passed (P = 0.731)

Group Name	N	Missing	Mean	Std Dev	SEM
asinsqrt-REF01	8	0	0.468	0.33	0.117
asinsqrt-REF02	8	0	0.76	0.223	0.0789
asinsqrt-SD04	8	0	0.335	0.257	0.0907
asinsqrt-SD09	8	0	1.049	0.18	0.0635
asinsqrt-SD12	8	0	0.354	0.25	0.0883
asinsqrt-SD15	8	0	0.196	0.299	0.106
asinsqrt-SD16	8	0	0.401	0.269	0.0952
asinsqrt-SD18	8	0	0.201	0.167	0.0589
asinsqrt-SD20	8	0	0.735	0.122	0.0433
asinsqrt-SD24	8	0	0.783	0.148	0.0525

Source of Variation	DF	SS	MS	F	P
Between Groups	9	5.896	0.655	11.998	<0.001
Residual	70	3.822	0.0546		
Total	79	9.718			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
asinsqrt-REF02 vs. asinsqrt-SD15	0.563	4.822	<0.001	Yes
asinsqrt-REF02 vs. asinsqrt-SD18	0.559	4.781	<0.001	Yes
asinsqrt-REF02 vs. asinsqrt-SD04	0.425	3.637	0.005	Yes
asinsqrt-REF02 vs. asinsqrt-SD12	0.405	3.469	0.008	Yes
asinsqrt-REF02 vs. asinsqrt-SD16	0.359	3.069	0.027	Yes
asinsqrt-REF02 vs. asinsqrt-REF01	0.291	2.493	0.135	No
asinsqrt-REF02 vs. asinsqrt-SD09	0.289	2.476	0.141	Do Not Test
asinsqrt-REF02 vs. asinsqrt-SD20	0.0246	0.211	1	Do Not Test
asinsqrt-REF02 vs. asinsqrt-SD24	0.0233	0.199	1	Do Not Test

Descriptive Statistics:

Data source: Data_Dried Weight (mg) in CH2M01-00146 (SWMU 2)_*Neanthes arenaceodentata*

Column	Size	Missing	Mean	Std Dev	Std. Error	C.I. of Mean	% Dried Weight Compared to:		
							LabCtl	2B-REF01	2B-REF02
LabCtl	8	0	2.163	1.092	0.386	0.913	-		
2B-REF01	8	0	4.717	1.221	0.432	1.021	218.08	-	127.97
2B-REF02	8	0	3.686	0.461	0.163	0.385	170.41	78.14	-
2B-SD04	8	0	5.52	0.808	0.286	0.675	255.20	117.02	149.76
2B-SD09	8	0	3.861	2.46	0.87	2.057	178.50	81.85	104.75
2B-SD12	8	0	3.972	0.828	0.293	0.692	183.63	84.21	107.76
2B-SD15	8	0	6.407	2.138	0.756	1.788	296.21	135.83	173.82
2B-SD16	8	0	4.747	0.829	0.293	0.693	219.46	100.64	128.78
2B-SD18	8	0	5.361	1.048	0.37	0.876	247.85	113.65	145.44
2B-SD20	8	0	3.434	0.516	0.183	0.432	158.76	72.80	93.16
2B-SD24	8	0	6.044	1.286	0.455	1.075	279.43	128.13	163.97

Column	Range	Max	Min	Median	5%	95%
LabCtl	3.324	3.711	0.388	2.312	0.388	3.711
2B-REF01	3.68	6.6	2.92	4.86	2.92	6.6
2B-REF02	1.475	4.375	2.9	3.717	2.9	4.375
2B-SD04	2.067	6.678	4.611	5.549	4.611	6.678
2B-SD09	7.325	9.5	2.175	2.933	2.175	9.5
2B-SD12	2.513	5.263	2.75	3.806	2.75	5.263
2B-SD15	6.891	9.911	3.02	6.036	3.02	9.911
2B-SD16	2.203	6.16	3.957	4.478	3.957	6.16
2B-SD18	3.133	6.944	3.811	5.606	3.811	6.944
2B-SD20	1.758	4.233	2.475	3.509	2.475	4.233
2B-SD24	3.075	7.225	4.15	6.662	4.15	7.225

Column	Skewness	Kurtosis	K-S Dist.	K-S Prob.	Sum	Sum of Squares
LabCtl	-0.308	-0.593	0.179	0.552	17.302	45.764
2B-REF01	-0.0333	-0.706	0.159	0.677	37.736	188.439
2B-REF02	-0.302	0.0731	0.0981	0.78	29.485	110.156
2B-SD04	0.132	-1.987	0.228	0.246	44.163	248.358
2B-SD09	2.11	4.79	0.247	0.162	30.888	161.623
2B-SD12	0.177	-0.796	0.188	0.496	31.772	130.979
2B-SD15	0.228	0.251	0.189	0.484	51.254	360.376
2B-SD16	1.08	-0.339	0.259	0.119	37.973	185.052
2B-SD18	-0.12	-0.895	0.157	0.687	42.889	237.614
2B-SD20	-0.571	1.338	0.223	0.271	27.475	96.229
2B-SD24	-0.76	-1.428	0.247	0.16	48.354	303.844

One Way Analysis of Variance

Data source: Data_Dried Weight (mg) in CH2M01-00146 (SWMU 2)_*Neanthes arenaceodentata*

Normality Test: Passed (P = 0.070)

Equal Variance Test: Passed (P = 0.231)

Group Name	N	Missing	Mean	Std Dev	SEM
LabCtl	8	0	2.163	1.092	0.386
2B-REF01	8	0	4.717	1.221	0.432
2B-REF02	8	0	3.686	0.461	0.163
2B-SD04	8	0	5.52	0.808	0.286
2B-SD09	8	0	3.861	2.46	0.87
2B-SD12	8	0	3.972	0.828	0.293
2B-SD15	8	0	6.407	2.138	0.756
2B-SD16	8	0	4.747	0.829	0.293
2B-SD18	8	0	5.361	1.048	0.37
2B-SD20	8	0	3.434	0.516	0.183
2B-SD24	8	0	6.044	1.286	0.455

Source of Variation	DF	SS	MS	F	P
Between Groups	10	126.753	12.675	7.511	<0.001
Residual	77	129.941	1.688		
Total	87	256.694			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
LabCtl vs. 2B-SD15	4.244	6.534	<0.001	Yes
LabCtl vs. 2B-SD24	3.882	5.976	<0.001	Yes
LabCtl vs. 2B-SD04	3.358	5.169	<0.001	Yes
LabCtl vs. 2B-SD18	3.198	4.924	<0.001	Yes
LabCtl vs. 2B-SD16	2.584	3.978	0.002	Yes
LabCtl vs. 2B-REF01	2.554	3.932	0.002	Yes
LabCtl vs. 2B-SD12	1.809	2.785	0.067	No
LabCtl vs. 2B-SD09	1.698	2.615	0.107	Do Not Test
LabCtl vs. 2B-REF02	1.523	2.345	0.216	Do Not Test
LabCtl vs. 2B-SD20	1.272	1.958	0.539	Do Not Test

One Way Analysis of Variance

Data source: Data_Dried Weight (mg) in CH2M01-00146 (SWMU 2)_*Neanthes arenaceodentata*

Normality Test: Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.203)

Group Name	N	Missing	Mean	Std Dev	SEM
2B-REF01	8	0	4.717	1.221	0.432
2B-REF02	8	0	3.686	0.461	0.163
2B-SD04	8	0	5.52	0.808	0.286
2B-SD09	8	0	3.861	2.46	0.87
2B-SD12	8	0	3.972	0.828	0.293
2B-SD15	8	0	6.407	2.138	0.756
2B-SD16	8	0	4.747	0.829	0.293
2B-SD18	8	0	5.361	1.048	0.37
2B-SD20	8	0	3.434	0.516	0.183
2B-SD24	8	0	6.044	1.286	0.455

Source of Variation	DF	SS	MS	F	P
Between Groups	9	77.132	8.57	4.934	<0.001
Residual	70	121.598	1.737		
Total	79	198.729			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 0.992

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
2B-REF01 vs. 2B-SD15	1.69	2.564	0.112	No
2B-REF01 vs. 2B-SD24	1.327	2.014	0.431	Do Not Test
2B-REF01 vs. 2B-SD20	1.283	1.946	0.501	Do Not Test
2B-REF01 vs. 2B-REF02	1.031	1.565	1	Do Not Test
2B-REF01 vs. 2B-SD09	0.856	1.299	1	Do Not Test
2B-REF01 vs. 2B-SD04	0.803	1.219	1	Do Not Test
2B-REF01 vs. 2B-SD12	0.745	1.131	1	Do Not Test
2B-REF01 vs. 2B-SD18	0.644	0.977	1	Do Not Test
2B-REF01 vs. 2B-SD16	0.0296	0.0449	1	Do Not Test

One Way Analysis of Variance

Data source: Data_Dried Weight (mg) in CH2M01-00146 (SWMU 2)_*Neanthes arenaceodentata*

Normality Test: Passed (P = 0.057)

Equal Variance Test: Passed (P = 0.203)

Group Name	N	Missing	Mean	Std Dev	SEM
2B-REF01	8	0	4.717	1.221	0.432
2B-REF02	8	0	3.686	0.461	0.163
2B-SD04	8	0	5.52	0.808	0.286
2B-SD09	8	0	3.861	2.46	0.87
2B-SD12	8	0	3.972	0.828	0.293
2B-SD15	8	0	6.407	2.138	0.756
2B-SD16	8	0	4.747	0.829	0.293
2B-SD18	8	0	5.361	1.048	0.37
2B-SD20	8	0	3.434	0.516	0.183
2B-SD24	8	0	6.044	1.286	0.455

Source of Variation	DF	SS	MS	F	P
Between Groups	9	77.132	8.57	4.934	<0.001
Residual	70	121.598	1.737		
Total	79	198.729			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 0.992

Multiple Comparisons versus Control Group (Bonferroni t-test):

Comparisons for factor:

Comparison	Diff of Means	t	P	P<0.050
2B-REF02 vs. 2B-SD15	2.721	4.129	<0.001	Yes
2B-REF02 vs. 2B-SD24	2.359	3.579	0.006	Yes
2B-REF02 vs. 2B-SD04	1.835	2.784	0.062	No
2B-REF02 vs. 2B-SD18	1.675	2.542	0.119	Do Not Test
2B-REF02 vs. 2B-SD16	1.061	1.61	1	Do Not Test
2B-REF02 vs. 2B-REF01	1.031	1.565	1	Do Not Test
2B-REF02 vs. 2B-SD12	0.286	0.434	1	Do Not Test
2B-REF02 vs. 2B-SD20	0.251	0.381	1	Do Not Test
2B-REF02 vs. 2B-SD09	0.175	0.266	1	Do Not Test

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
0	06/15/07	RR	-	Lab Control	20.0	6.9	7.9	29.6	0.55	0.04
			016	2B-EWSD-04	20.0	6.8	7.4	31.1	0.40	<0.01
			017	2B-EWSD-09	20.0	7.2	7.7	31.2	0.30	<0.01
			018	2B-EWSD-12	20.0	7.0	7.1	31.4	0.20	0.01
			019	2B-EWSD-15	20.0	6.8	7.1	31.7	1.00	0.02
			020	2B-EWSD-16	20.0	7.3	7.6	30.9	0.05	0.01
			021	2B-EWSD-18	20.0	6.6	7.1	31.1	0.65	0.01
			022	2B-EWSD-20	20.0	7.1	7.2	30.7	0.20	0.01
			023	2B-EWSD-24	20.0	7.1	7.8	31.0	0.15	0.01
			024	2B-REF-EWSD-01	20.0	6.8	7.4	31.5	1.05	0.04
			025	2B-REF-EWSD-02	20.0	7.0	7.1	31.6	2.03	0.04
1	06/16/07	RR	-	Lab Control	20.0	7.1	7.9			
			016	2B-EWSD-04	20.0	7.0	7.6			
			017	2B-EWSD-09	20.0	7.0	7.7			
			018	2B-EWSD-12	20.0	7.0	7.0			
			019	2B-EWSD-15	20.0	6.8	7.1			
			020	2B-EWSD-16	20.0	7.4	7.7			
			021	2B-EWSD-18	20.0	6.6	7.1			
			022	2B-EWSD-20	20.0	7.0	7.2			
			023	2B-EWSD-24	20.0	7.3	7.8			
			024	2B-REF-EWSD-01	20.0	6.9	7.3			
			025	2B-REF-EWSD-02	20.0	6.8	7.0			
2	06/17/07	RR	-	Lab Control	19.5	7.0	7.9			
			016	2B-EWSD-04	19.5	7.4	7.6			
			017	2B-EWSD-09	19.5	7.2	7.7			
			018	2B-EWSD-12	19.5	6.9	7.0			
			019	2B-EWSD-15	19.5	6.6	7.1			
			020	2B-EWSD-16	19.5	7.1	7.7			
			021	2B-EWSD-18	19.5	6.9	7.1			
			022	2B-EWSD-20	19.5	7.0	7.2			
			023	2B-EWSD-24	19.5	7.0	7.8			
			024	2B-REF-EWSD-01	19.5	7.0	7.4			
			025	2B-REF-EWSD-02	19.5	7.1	7.0			
3	06/18/07	RR	-	Lab Control	21.0	6.9	7.9			
			016	2B-EWSD-04	21.0	6.9	7.5			
			017	2B-EWSD-09	21.0	7.0	7.6			
			018	2B-EWSD-12	21.0	7.1	7.1			
			019	2B-EWSD-15	21.0	6.8	7.6			
			020	2B-EWSD-16	21.0	7.2	7.1			
			021	2B-EWSD-18	21.0	6.7	7.1			
			022	2B-EWSD-20	21.0	7.2	7.8			
			023	2B-EWSD-24	21.0	7.2	7.8			
			024	2B-REF-EWSD-01	21.0	6.8	7.5			
			025	2B-REF-EWSD-02	21.0	6.9	7.2			

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
4	06/19/07	RR/WH	-	Lab Control	21.0	6.9	7.9			
			016	2B-EWSD-04	21.0	6.7	7.5			
			017	2B-EWSD-09	21.0	7.2	7.7			
			018	2B-EWSD-12	21.0	7.0	7.0			
			019	2B-EWSD-15	21.0	6.6	7.1			
			020	2B-EWSD-16	21.0	7.4	7.7			
			021	2B-EWSD-18	21.0	6.6	7.1			
			022	2B-EWSD-20	21.0	7.2	7.1			
			023	2B-EWSD-24	21.0	7.3	7.9			
			024	2B-REF-EWSD-01	21.0	6.9	7.4			
			025	2B-REF-EWSD-02	21.0	6.9	7.1			
5	06/20/07	WH	-	Lab Control	21.0	7.0	8.0	32.8	0.60	<0.01
			016	2B-EWSD-04	21.0	6.8	7.5	38.5	9.25	<0.01
			017	2B-EWSD-09	21.0	7.1	7.6	41.2	4.25	<0.01
			018	2B-EWSD-12	21.0	7.0	7.4	38.0	4.75	0.02
			019	2B-EWSD-15	21.0	6.6	6.8	42.5	3.20	<0.01
			020	2B-EWSD-16	21.0	7.3	7.6	36.7	5.75	<0.01
			021	2B-EWSD-18	21.0	6.9	7.4	41.5	5.95	0.03
			022	2B-EWSD-20	21.0	6.9	7.1	36.3	3.35	0.03
			023	2B-EWSD-24	21.0	7.0	8.0	34.4	2.50	0.01
			024	2B-REF-EWSD-01	21.0	6.9	7.0	37.9	3.25	0.02
			025	2B-REF-EWSD-02	21.0	7.0	7.2	36.9	6.65	0.02
6	06/21/07	WH	-	Lab Control	21.0	7.4				
			016	2B-EWSD-04	21.0	8.5				
			017	2B-EWSD-09	21.0	7.2				
			018	2B-EWSD-12	21.0	7.1				
			019	2B-EWSD-15	21.0	7.1				
			020	2B-EWSD-16	21.0	7.5				
			021	2B-EWSD-18	21.0	6.8				
			022	2B-EWSD-20	21.0	7.0				
			023	2B-EWSD-24	21.0	7.3				
			024	2B-REF-EWSD-01	21.0	7.5				
			025	2B-REF-EWSD-02	21.0	6.6				
7	06/22/07	WH	-	Lab Control	21.0	6.2				
			016	2B-EWSD-04	21.0	7.1				
			017	2B-EWSD-09	21.0	7.6				
			018	2B-EWSD-12	21.0	6.9				
			019	2B-EWSD-15	21.0	6.4				
			020	2B-EWSD-16	21.0	8.0				
			021	2B-EWSD-18	21.0	7.2				
			022	2B-EWSD-20	21.0	6.8				
			023	2B-EWSD-24	21.0	7.8				
			024	2B-REF-EWSD-01	21.0	7.4				
			025	2B-REF-EWSD-02	21.0	7.0				

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
8	06/23/07	WH	-	Lab Control	21.0	6.6				
			016	2B-EWSD-04	21.0	7.2				
			017	2B-EWSD-09	21.0	7.0				
			018	2B-EWSD-12	21.0	6.8				
			019	2B-EWSD-15	21.0	7.4				
			020	2B-EWSD-16	21.0	7.5				
			021	2B-EWSD-18	21.0	7.1				
			022	2B-EWSD-20	21.0	6.9				
			023	2B-EWSD-24	21.0	7.0				
			024	2B-REF-EWSD-01	21.0	7.4				
			025	2B-REF-EWSD-02	21.0	7.8				
9	06/24/07	WH	-	Lab Control	20.5	7.2				
			016	2B-EWSD-04	20.5	7.7				
			017	2B-EWSD-09	20.5	7.6				
			018	2B-EWSD-12	20.5	7.0				
			019	2B-EWSD-15	20.5	6.6				
			020	2B-EWSD-16	20.5	6.9				
			021	2B-EWSD-18	20.5	7.3				
			022	2B-EWSD-20	20.5	7.3				
			023	2B-EWSD-24	20.5	7.1				
			024	2B-REF-EWSD-01	20.5	7.1				
			025	2B-REF-EWSD-02	20.5	6.8				
10	06/25/07	WH	-	Lab Control	21.0	7.1				
			016	2B-EWSD-04	21.0	6.9				
			017	2B-EWSD-09	21.0	7.4				
			018	2B-EWSD-12	21.0	7.0				
			019	2B-EWSD-15	21.0	6.8				
			020	2B-EWSD-16	21.0	6.9				
			021	2B-EWSD-18	21.0	7.3				
			022	2B-EWSD-20	21.0	7.2				
			023	2B-EWSD-24	21.0	7.2				
			024	2B-REF-EWSD-01	21.0	7.7				
			025	2B-REF-EWSD-02	21.0	8.0				
11	06/26/07	WH	-	Lab Control	21.0	7.6				
			016	2B-EWSD-04	21.0	6.9				
			017	2B-EWSD-09	21.0	7.4				
			018	2B-EWSD-12	21.0	7.3				
			019	2B-EWSD-15	21.0	7.3				
			020	2B-EWSD-16	21.0	7.8				
			021	2B-EWSD-18	21.0	8.0				
			022	2B-EWSD-20	21.0	6.8				
			023	2B-EWSD-24	21.0	6.7				
			024	2B-REF-EWSD-01	21.0	7.3				
			025	2B-REF-EWSD-02	21.0	7.1				

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
12	06/27/07	WH	-	Lab Control	21.0	6.4				
			016	2B-EWSD-04	21.0	6.6				
			017	2B-EWSD-09	21.0	7.9				
			018	2B-EWSD-12	21.0	6.2				
			019	2B-EWSD-15	21.0	6.4				
			020	2B-EWSD-16	21.0	6.7				
			021	2B-EWSD-18	21.0	7.1				
			022	2B-EWSD-20	21.0	7.0				
			023	2B-EWSD-24	21.0	6.9				
			024	2B-REF-EWSD-01	21.0	7.4				
			025	2B-REF-EWSD-02	21.0	7.2				
13	06/28/07	WH	-	Lab Control	21.0	6.4	7.7	39.7	0.55	<0.01
			016	2B-EWSD-04	21.0	7.0	7.9	44.3	0.25	<0.01
			017	2B-EWSD-09	21.0	7.6	8.0	44.0	0.10	0.01
			018	2B-EWSD-12	21.0	6.5	8.0	44.1	0.80	0.02
			019	2B-EWSD-15	21.0	6.2	8.0	48.9	6.95	<0.01
			020	2B-EWSD-16	21.0	7.4	8.1	44.0	0.15	0.01
			021	2B-EWSD-18	21.0	6.2	7.9	45.1	0.60	<0.01
			022	2B-EWSD-20	21.0	6.9	8.0	42.6	0.20	0.01
			023	2B-EWSD-24	21.0	7.4	8.0	40.6	0.30	<0.01
			024	2B-REF-EWSD-01	21.0	7.4	8.0	45.4	4.15	0.07
			025	2B-REF-EWSD-02	21.0	7.3	6.5	49.1	6.88	0.03
14	06/29/07	WH	-	Lab Control	21.0	5.5				
			016	2B-EWSD-04	21.0	5.8				
			017	2B-EWSD-09	21.0	6.9				
			018	2B-EWSD-12	21.0	5.4				
			019	2B-EWSD-15	21.0	6.0				
			020	2B-EWSD-16	21.0	6.7				
			021	2B-EWSD-18	21.0	5.6				
			022	2B-EWSD-20	21.0	5.7				
			023	2B-EWSD-24	21.0	6.4				
			024	2B-REF-EWSD-01	21.0	6.0				
			025	2B-REF-EWSD-02	21.0	6.2				
15	06/30/07	WH	-	Lab Control	21.0	6.4				
			016	2B-EWSD-04	21.0	6.9				
			017	2B-EWSD-09	21.0	7.2				
			018	2B-EWSD-12	21.0	7.1				
			019	2B-EWSD-15	21.0	7.2				
			020	2B-EWSD-16	21.0	7.0				
			021	2B-EWSD-18	21.0	7.0				
			022	2B-EWSD-20	21.0	6.8				
			023	2B-EWSD-24	21.0	6.9				
			024	2B-REF-EWSD-01	21.0	6.9				
			025	2B-REF-EWSD-02	21.0	6.3				

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
16	07/01/07	WH	-	Lab Control	20.5	6.4				
			016	2B-EWSD-04	20.5	6.4				
			017	2B-EWSD-09	20.5	6.8				
			018	2B-EWSD-12	20.5	6.9				
			019	2B-EWSD-15	20.5	6.8				
			020	2B-EWSD-16	20.5	7.0				
			021	2B-EWSD-18	20.5	7.2				
			022	2B-EWSD-20	20.5	7.4				
			023	2B-EWSD-24	20.5	7.4				
			024	2B-REF-EWSD-01	20.5	7.0				
			025	2B-REF-EWSD-02	20.5	7.0				
17	07/02/07	WH	-	Lab Control	21.0	7.0				
			016	2B-EWSD-04	21.0	7.3				
			017	2B-EWSD-09	21.0	7.1				
			018	2B-EWSD-12	21.0	6.4				
			019	2B-EWSD-15	21.0	6.9				
			020	2B-EWSD-16	21.0	6.4				
			021	2B-EWSD-18	21.0	6.6				
			022	2B-EWSD-20	21.0	6.9				
			023	2B-EWSD-24	21.0	7.1				
			024	2B-REF-EWSD-01	21.0	7.0				
			025	2B-REF-EWSD-02	21.0	7.0				
18	07/03/07	WH	-	Lab Control	21.0	5.4				
			016	2B-EWSD-04	21.0	6.4				
			017	2B-EWSD-09	21.0	7.4				
			018	2B-EWSD-12	21.0	5.1				
			019	2B-EWSD-15	21.0	5.6				
			020	2B-EWSD-16	21.0	7.1				
			021	2B-EWSD-18	21.0	5.4				
			022	2B-EWSD-20	21.0	6.3				
			023	2B-EWSD-24	21.0	7.1				
			024	2B-REF-EWSD-01	21.0	6.7				
			025	2B-REF-EWSD-02	21.0	6.3				
19	07/04/07	WH	-	Lab Control	21.0	5.0				
			016	2B-EWSD-04	21.0	6.1				
			017	2B-EWSD-09	21.0	7.2				
			018	2B-EWSD-12	21.0	5.3				
			019	2B-EWSD-15	21.0	5.8				
			020	2B-EWSD-16	21.0	7.2				
			021	2B-EWSD-18	21.0	5.6				
			022	2B-EWSD-20	21.0	6.1				
			023	2B-EWSD-24	21.0	6.9				
			024	2B-REF-EWSD-01	21.0	6.9				
			025	2B-REF-EWSD-02	21.0	6.4				

OVERLYING WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	Temp (C)	DO (mg/L)	pH (su)	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
20	07/05/07	WH/SM	-	Lab Control	21.0	4.9	8.0	38.9	13.10	0.04
			016	2B-EWSD-04	21.0	6.5	8.2	43.4	0.50	0.01
			017	2B-EWSD-09	21.0	7.5	8.2	46.4	1.25	<0.01
			018	2B-EWSD-12	21.0	5.3	8.2	43.7	0.60	0.01
			019	2B-EWSD-15	21.0	5.7	8.2	47.9	4.85	0.02
			020	2B-EWSD-16	21.0	7.2	8.3	45.0	1.20	<0.01
			021	2B-EWSD-18	21.0	5.5	8.1	49.3	1.70	<0.01
			022	2B-EWSD-20	21.0	6.5	8.2	44.5	0.50	0.01
			023	2B-EWSD-24	21.0	7.2	8.3	43.1	0.35	<0.01
			024	2B-REF-EWSD-01	21.0	6.8	7.0	45.8	3.00	0.01
			025	2B-REF-EWSD-02	21.0	6.1	6.5	45.6	3.73	<0.01

PORE WATER CHEMISTRY
CH2M06-00146 (SWMU 2)
Test Species: *Neanthes arenaceodentata*

Study Day	Study Date	Tech Initials	FEL Sample No.	Sample ID	pH	Salinity (ppt)	NH ₃ -N (mg/L)	Sulfide (mg/L)
-17	05/30/07	WH/RR	016	2B-EWSD-04	7.5	43.1	0.65	0.08
			017	2B-EWSD-09	No initial pore water- Dry sediment			
			018	2B-EWSD-12	7.7	36.9	0.50	0.11
			019	2B-EWSD-15	7.8	54.2	0.80	1.11
			020	2B-EWSD-16	No initial pore water- Dry sediment			
			021	2B-EWSD-18	No initial pore water- Sediment consistency of putty			
			022	2B-EWSD-20	7.9	39.9	0.75	0.12
			023	2B-EWSD-24	No initial pore water- Dry sediment			
			024	2B-REF-EWSD-01	7.7	57.5	0.75	0.10
			025	2B-REF-EWSD-02	7.0	52.5	2.08	0.06
20	07/05/07	WH	016	2B-EWSD-04	8.0	31.7	5.90	0.01
			017	2B-EWSD-09	8.3	33.3	9.45	0.06
			018	2B-EWSD-12	8.2	49.5	1.65	0.07
			019	2B-EWSD-15	8.3	48.9	2.25	0.18
			020	2B-EWSD-16	8.2	30.4	6.20	0.35
			021	2B-EWSD-18	8.0	31.9	10.60	0.31
			022	2B-EWSD-20	8.3	31.1	8.90	0.24
			023	2B-EWSD-24	8.4	31.3	9.40	1.70
			024	2B-REF-EWSD-01	6.7	32.8	11.35	0.31
			025	2B-REF-EWSD-02	3.5	59.2	6.50	0.35

APPENDIX F
DATA VALIDATION NARRATIVES

SEVERN TRENT - SAVANNAH SDG SWMU24740-1

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 680-24740-1
Fraction: Inorganic
Matrix: Soil
Report Date: 10/9/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil and sediment samples. One matrix spike sample/matrix spike duplicate was submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for miscellaneous parameters: pH, total organic carbon, ammonia, and sulfide. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

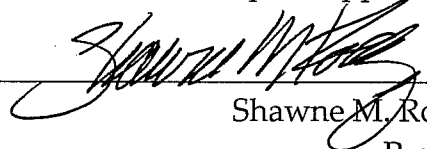
All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

-
- X • Data Completeness
 - X • Chain of Custody Documentation
 - X • Holding Times
 - X • Initial and Continuing Calibrations
 - X • ICP Interference Check Sample Results
 - X • Laboratory and Field Blank Analysis Results
 - X • Matrix Spike Recoveries and Reproducibility
 - X • Laboratory Duplicate Analysis Results
 - ICP Serial Dilution Results
 - Field Duplicate Analysis Results
 - X • Laboratory Control Sample Results
 - GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
 - X • Qualitative Identification
 - X • Quantitation/Reporting Limits
-

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:


Shawne M. Rodgers
President


Date

1.0 DATA COMPLETENESS

All criteria were met. No qualifiers were applied.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

This parameter is not applicable to the analyses performed.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

All criteria were met. No qualifiers were applied.

8.0 *LABORATORY DUPLICATE RESULTS*

All criteria were met. No qualifiers were applied.

9.0 *ICP SERIAL DILUTION RESULTS*

This parameter is not applicable to the analyses performed.

10.0 *FIELD DUPLICATE RESULTS*

There were no field duplicate samples submitted with this SDG.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

14.0 *QUANTITATION/REPORTING LIMITS*

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Ammonia	Method 350.1 , "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, March 1983, and revisions
Sulfide	Method 9034, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Total Organic Carbon	Lloyd-Kahn
pH	Method 9045C, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected February 2007
Severn Trent Sample Delivery Group SWMU24740-1

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED		
				MISC1	MISC2	MISC3
1V-SS01	680-24740- 1	2/27/2007	Soil		X	X
1V-SS02	680-24740- 2	2/27/2007	Soil		X	X
1V-SS03	680-24740- 3	2/27/2007	Soil		X	X
1V-SS04	680-24740- 4	2/27/2007	Soil		X	X
1V-SS05	680-24740- 5	2/27/2007	Soil		X	X
1V-SS06	680-24740- 6	2/27/2007	Soil		X	X
2V-SS01	680-24740- 7	2/27/2007	Soil		X	X
2V-SS02	680-24740- 8	2/27/2007	Soil		X	X
2V-SS03	680-24740- 9	2/27/2007	Soil		X	X
2V-SS04	680-24740- 10	2/27/2007	Soil		X	X
2V-SS05	680-24740- 11	2/27/2007	Soil		X	X
2V-SS06	680-24740- 12	2/27/2007	Soil		X	X
2V-SB01	680-24740- 13	2/27/2007	Soil		X	X
2V-SB02	680-24740- 14	2/27/2007	Soil		X	X
2V-SB03	680-24740- 15	2/27/2007	Soil		X	X
2V-SB04	680-24740- 16	2/27/2007	Soil		X	X
2V-SB05	680-24740- 17	2/27/2007	Soil		X	X
2V-SB06	680-24740- 18	2/27/2007	Soil		X	X
2V-EWSD01	680-24740- 19	2/28/2007	Soil	X		X
2V-EWSD02	680-24740- 20	2/28/2007	Soil	X		X
2V-EWSD03	680-24740- 21	2/28/2007	Soil	X		X
2V-EWSD04	680-24740- 22	2/28/2007	Soil	X		X
2V-EWSD05	680-24740- 23	2/28/2007	Soil	X		X
2V-EWSD06	680-24740- 24	2/28/2007	Soil	X		X

MISC1 Ammonia and Sulfide

MISC2 Total Organic Carbon

MISC3 Grain Size and pH

SEVERN TRENT - SAVANNAH SDG SWMU24740-2/SWMU24740-3

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 680-24740-2/ 680-24740-3
Fraction: Inorganic
Matrix: Soil
Report Date: 10/12/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil and sediment samples. Three equipment blanks, one field blank, four field duplicates and four matrix spike sample/matrix spike duplicates, were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for metals and miscellaneous parameters: pH, total organic carbon, ammonia, and sulfide. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

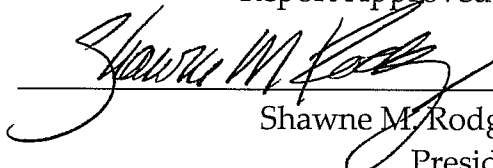
All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.


-
- X • Data Completeness
 - X • Chain of Custody Documentation
 - X • Holding Times
 - X • Initial and Continuing Calibrations
 - X • ICP Interference Check Sample Results
 - X • Laboratory and Field Blank Analysis Results
 - X • Matrix Spike Recoveries and Reproducibility
 - X • Laboratory Duplicate Analysis Results
 - X • ICP Serial Dilution Results
 - X • Field Duplicate Analysis Results
 - X • Laboratory Control Sample Results
 - GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
 - X • Qualitative Identification
 - X • Quantitation/Reporting Limits
-

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:


Shawne M. Rodgers
President


Date

1.0 DATA COMPLETENESS

All criteria were met. No qualifiers were applied.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0

MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

Positive results for chromium, copper, vanadium, and zinc for samples REF-SB01, REF-SB01D, REF-SB02, REF-SB04, and REF-SB06, should be considered biased high quantitative estimates and may be lower than reported. The associated matrix spike recoveries were above the acceptance limit for these analytes. The high recoveries indicate the presence of interferences for chromium, copper, vanadium, and zinc for samples of similar matrix. The positive results have been marked "K" to indicate that they are biased high quantitative estimates.

Positive results for zinc for samples REF-EWSD01, REF-EWSD01D, REF-EWSD02, REF-EWSD04, REF-EWSD05, and REF-EWSD06 are biased low quantitative estimates and may be higher than reported. The associated matrix spike recovery was below the acceptance limit for this analyte. The low recovery indicates the presence of interferences for zinc for samples of similar matrix. Positive results have been marked "L" to indicate that they are biased low.

8.0

LABORATORY DUPLICATE RESULTS

All criteria were met. No qualifiers were applied.

9.0

ICP SERIAL DILUTION RESULTS

The following positive results should be considered quantitative estimates. The ICP serial dilution criterion was exceeded for these elements. The lack of precision may be due to interferences in samples of similar matrix. The positive results for these metals have been marked with "J" qualifiers to indicate that they are quantitative estimates.

Analyte	Affected Samples
Barium	REF-SS01, REF-SS01D, REF-SS05, REF-SS06, REF-SS09, REF-SS010
Copper	REF-EWSD01, REF-EWSD01D, REF-EWSD02, REF-EWSD03, REF-EWSD04, REF-EWSD05, REF-EWSD06

10.0 FIELD DUPLICATE RESULTS

Duplicate samples REF-SS01 and REF-SS01D, REF-SS03 and REF-SS03D, REF-SB01 and REF-SB01D, and REF-EWSD01 and REF-EWSD01D were submitted to the laboratory evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Table 2 through 5. The Region II field duplicate criteria were met for the duplicate samples.

11.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

12.0 GFAA POST-DIGESTION SPIKE/DUPLICATE BURN

This parameter is not applicable to the analyses performed.

13.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

Positive results and quantitation limits for all inorganic analytes for samples REF-SS02, REF-EWSD02, REF-EWSD04, and REF-EWSD05, that were not previously qualified for other criteria, should be considered biased low quantitative estimates, and may be higher than reported. The percent solids for these sediment samples were less than 50 percent. The positive results have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates. The quantitation limits have been marked "UJ".

METHODOLOGY REFERENCES

Analysis	Reference
Metals (Except Mercury)	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Ammonia	Method 350.1, "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, March 1983, and revisions
Sulfide	Method 9034, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Total Organic Carbon	Lloyd-Kahn
pH	Method 9045C, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED									
				PAH	APP IX PEST	TPEST	APP IX MET	TMET1	TMET2	MISC1	MISC2	MISC3	
REF-SS01	680-24740-25	2/28/2007	Soil	X	X		X				X		X
REF-SS01D	680-24740-26	2/28/2007	Soil	X	X		X						
REF-SS02	680-24740-27	2/28/2007	Soil	X	X		X				X		X
REF-SS03	680-24740-28	2/28/2007	Soil			X		X			X		X
REF-SS03D	680-24740-29	2/28/2007	Soil			X		X					
REF-SS04	680-24740-30	2/28/2007	Soil			X		X			X		X
REF-SS05	680-24740-31	2/28/2007	Soil	X	X		X				X		X
REF-SS06	680-24740-32	2/28/2007	Soil	X	X		X				X		X
REF-SS07	680-24740-33	2/28/2007	Soil			X		X			X		X
REF-SS08	680-24740-34	2/28/2007	Soil			X		X			X		X
REF-SS09	680-24740-35	2/28/2007	Soil	X	X		X				X		X
REF-SS010	680-24740-36	2/28/2007	Soil	X	X		X				X		X
REF-SS011	680-24740-37	2/28/2007	Soil			X		X			X		X
REF-SS012	680-24740-38	2/28/2007	Soil			X		X			X		X
REF-SB01	680-24740-39	2/28/2007	Soil	X	X		X				X		X
REF-SB01D	680-24740-40	2/28/2007	Soil	X	X		X						
REF-SB02	680-24740-41	2/28/2007	Soil	X	X		X				X		X
REF-SB03	680-24740-42	2/28/2007	Soil			X		X			X		X
REF-SB04	680-24740-43	2/28/2007	Soil			X		X			X		X

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-2

SAMPLE I.D.	LABORATORY LD	DATE COLLECTED	MATRIX	ANALYSES PERFORMED								
				PAH	APP IX PEST	TPEST	APP IX MET	TMET1	TMET2	MISC1	MISC2	MISC3
REF-SB06	680-24740-44	2/28/2007	Soil	X	X		X			X		X
REF-SB07	680-24740-45	2/28/2007	Soil			X		X		X		X
REF-SB08	680-24740-46	2/28/2007	Soil			X		X		X		X
REF-SB09	680-24740-47	2/28/2007	Soil	X	X		X			X		X
REF-SB010	680-24740-48	2/28/2007	Soil	X	X		X			X		X
REF-SB011	680-24740-49	2/28/2007	Soil			X		X		X		X
REF-SB012	680-24740-50	2/28/2007	Soil			X		X		X		X
REF-EWSD01	680-24740-51	3/1/2007	Sediment							X	X	X
REF-EWSD01D	680-24740-52	3/1/2007	Sediment						X			
REF-EWSD02	680-24740-53	3/1/2007	Sediment						X	X	X	X
REF-EWSD03	680-24740-54	3/1/2007	Sediment						X	X	X	X
REF-EWSD04	680-24740-55	3/1/2007	Sediment						X	X	X	X
REF-EWSD05	680-24740-56	3/1/2007	Sediment						X	X	X	X
REF-EWSD06	680-24740-57	3/1/2007	Sediment						X	X	X	X

PAH Polynuclear Aromatic Hydrocarbons
APP IX PEST Appendix IX Organochlorine Pesticides
PEST 4,4'-DDD, 4,4'-DDE, 4,4'-DDT
APP IX MET Appendix IX Metals
TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc
TMET2 Total Metals: Copper, Lead, Mercury, Zinc
MISC1 Ammonia and Sulfide
MISC2 Total Organic Carbon
MISC3 Grain Size and pH

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-3

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED			
				PAH	APP IX PEST	APP IX MET	TMET2
1V-ER01	680-24740- 58	2/27/2007	Equipment Blank	X	X	X	
2V-ER01	680-24740- 59	2/28/2007	Equipment Blank	X	X	X	
REF-ER01	680-24740- 60	3/1/2007	Equipment Blank				X
1V-FB01	680-24740- 61	2/27/2007	Field Blank	X	X	X	

PAH Polynuclear Aromatic Hydrocarbons
APP IX PEST Appendix IX Organochlorine Pesticides
APP IX MET Appendix IX Metals
TMET2 Total Metals: Copper, Lead, Mercury, Zinc

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 680-24740-2/ 680-24740-3
Fraction: Organic
Matrix: Soil
Report Date: 10/12/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil and sediment samples. Three equipment blanks, one field blank, three field duplicates and three matrix spike sample/matrix spike duplicates, were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for polynuclear aromatic hydrocarbons and pesticide compounds. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

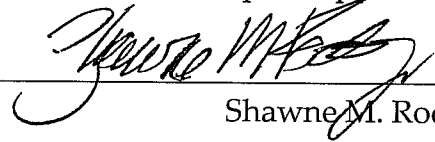
All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to Region II "Validating Semivolatile Organic Compounds by SW-846 Method 8270C", SOP HW-22 Revision 2, June 2001, and "SW-846 Method 8080A/8000A", SOP HW-23, Revision 0, April 1995. The parameters presented on the following page were evaluated.

X	•	Data Completeness
X	•	Chain of Custody Documentation
X	•	Holding Times
	•	Instrument Performance
X	•	Initial and Continuing Calibrations
X	•	Laboratory and Field Blank Analysis Results
X	•	Surrogate Compound Recoveries
X	•	Matrix Spike/Matrix Spike Duplicate Recoveries and Reproducibility
X	•	Field Duplicate Analysis Results
X	•	Laboratory Control Sample Results
X	•	Internal Standard Performance
X	•	Qualitative Identification
X	•	Quantitation/Reporting Limits

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:



Shawne M. Rodgers
President



Date

1.0 DATA COMPLETENESS

The data package was complete.

2.0 CHAIN OF CUSTODY DOCUMENTATION

The chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INSTRUMENT PERFORMANCE

All criteria were met. No qualifiers were applied.

5.0 INITIAL AND CONTINUING CALIBRATIONS

The laboratory evaluated the samples using guidance given in the DOD QSM Final Version 3, which allows for 20% difference as the continuing calibration verification criteria. This is a deviation from Method 8081A, which allows for a 15% difference. This has been noted in the case narrative.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 SURROGATE COMPOUND RECOVERIES

All criteria were met. No qualifiers were applied.

8.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

All criteria were met. No qualifiers were applied.

9.0 FIELD DUPLICATE RESULTS

Duplicate samples REF-SS01 and REF-SS01D, REF-SS03 and REF-SS03D, and REF-SB01 and REF-SB01D were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Tables 2 through 4. Precision is evaluated by calculating the relative percent difference (%RPD) between duplicate pair results. There are no USEPA-established acceptance criteria for field duplicate samples. EDQ uses internal acceptance criteria of forty percent for extractable compounds to evaluate soil field duplicate samples.

10.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

11.0 INTERNAL STANDARD PERFORMANCE

All criteria were met. No qualifiers were applied.

12.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

13.0 *QUANTITATION/REPORTING LIMITS*

As required by USEPA protocol, all compounds, which were qualitatively identified at concentrations below their respective Reporting Limits (RLs), have been marked with "J" qualifiers to indicate that they are quantitative estimates.

METHODOLOGY REFERENCES

Analysis	Reference
Polynuclear Aromatic Hydrocarbons (SIM)	Method 8270C, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Pesticide Compounds	Method 8081A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED								
				PAH	APP IX PEST	TPEST	APP IX MET	TMET1	TMET2	MISC1	MISC2	MISC3
REF-SS01	680-24740-25	2/28/2007	Soil	X	X		X			X		X
REF-SS01D	680-24740-26	2/28/2007	Soil	X	X		X					
REF-SS02	680-24740-27	2/28/2007	Soil	X	X		X			X		X
REF-SS03	680-24740-28	2/28/2007	Soil			X		X		X		X
REF-SS03D	680-24740-29	2/28/2007	Soil			X		X				
REF-SS04	680-24740-30	2/28/2007	Soil			X		X		X		X
REF-SS05	680-24740-31	2/28/2007	Soil	X	X		X			X		X
REF-SS06	680-24740-32	2/28/2007	Soil	X	X		X			X		X
REF-SS07	680-24740-33	2/28/2007	Soil			X		X		X		X
REF-SS08	680-24740-34	2/28/2007	Soil			X		X		X		X
REF-SS09	680-24740-35	2/28/2007	Soil	X	X		X			X		X
REF-SS010	680-24740-36	2/28/2007	Soil	X	X		X			X		X
REF-SS011	680-24740-37	2/28/2007	Soil			X		X		X		X
REF-SS012	680-24740-38	2/28/2007	Soil			X		X		X		X
REF-SB01	680-24740-39	2/28/2007	Soil	X	X		X			X		X
REF-SB01D	680-24740-40	2/28/2007	Soil	X	X		X					
REF-SB02	680-24740-41	2/28/2007	Soil	X	X		X			X		X
REF-SB03	680-24740-42	2/28/2007	Soil			X		X		X		X
REF-SB04	680-24740-43	2/28/2007	Soil			X		X		X		X

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED								
				PAH	APP IX PEST	TPEST	APP IX MET	TMET1	TMET2	MISC1	MISC2	MISC3
REF-SB06	680-24740-44	2/28/2007	Soil	X	X		X			X		X
REF-SB07	680-24740-45	2/28/2007	Soil			X		X		X		X
REF-SB08	680-24740-46	2/28/2007	Soil			X		X		X		X
REF-SB09	680-24740-47	2/28/2007	Soil	X	X		X			X		X
REF-SB010	680-24740-48	2/28/2007	Soil	X	X		X			X		X
REF-SB011	680-24740-49	2/28/2007	Soil			X		X		X		X
REF-SB012	680-24740-50	2/28/2007	Soil			X		X		X		X
REF-EWSD01	680-24740-51	3/1/2007	Sediment							X	X	X
REF-EWSD01D	680-24740-52	3/1/2007	Sediment						X			
REF-EWSD02	680-24740-53	3/1/2007	Sediment						X	X	X	X
REF-EWSD03	680-24740-54	3/1/2007	Sediment						X	X	X	X
REF-EWSD04	680-24740-55	3/1/2007	Sediment						X	X	X	X
REF-EWSD05	680-24740-56	3/1/2007	Sediment						X	X	X	X
REF-EWSD06	680-24740-57	3/1/2007	Sediment						X	X	X	X

PAH Polynuclear Aromatic Hydrocarbons
APP IX PEST Appendix IX Organochlorine Pesticides
PEST 4,4'-DDD, 4,4'-DDE, 4,4'-DDT
APP IX MET Appendix IX Metals
TMET1 Total Metals: Antimony, Cadmium, Copper, Lead, Mercury, Tin, Zinc
TMET2 Total Metals: Copper, Lead, Mercury, Zinc
MISC1 Ammonia and Sulfide
MISC2 Total Organic Carbon
MISC3 Grain Size and pH

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected February and March 2007
Severn Trent Sample Delivery Group 680-24740-3

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED			
				PAH	APP IX PEST	APP IX MET	TMET2
1V-ER01	680-24740- 58	2/27/2007	Equipment Blank	X	X	X	
2V-ER01	680-24740- 59	2/28/2007	Equipment Blank	X	X	X	
REF-ER01	680-24740- 60	3/1/2007	Equipment Blank				X
1V-FB01	680-24740- 61	2/27/2007	Field Blank	X	X	X	

PAH Polynuclear Aromatic Hydrocarbons
APP IX PEST Appendix IX Organochlorine Pesticides
APP IX MET Appendix IX Metals
TMET2 Total Metals: Copper, Lead, Mercury, Zinc

SEVERN TRENT - SAVANNAH SDG PRN20478

DataQual

Environmental Services, LLC

Michael Baker Jr., Inc.
 Airside Business Park
 100 Airside Drive
 Moon Township, PA 15108

October 31, 2006
 SDG# PRN20478, STL Savannah
 SWMU 45, CTO-0108, Ceiba Puerto Rico

Dear Mr. Kimes,

The following Data Validation report is provided as requested for the parameters noted in the table below for SDG # PRN20478. The site is in Region II. The validation was performed using the Region II SOP HW-23B, Revision 1.0 for SW-846 method 8082 for AR1260 and the Region II SOP HW-2 Revision 13 for the evaluation of metals data, as applicable. All areas of concern are discussed in the body of the report and a summary of data qualifications is provided.

Sample ID	Lab ID	Matrix	AR1260	Select Metals
45B-SD01V	680-20478-1	sediment	X	X
REF1-SD04V	680-20478-10	sediment	X	X
REF1-SD05V	680-20478-11	sediment	X	X
REF1-SD06V	680-20478-12	sediment	X	X
REF2-SD01V	680-20478-13	sediment	X	X
REF2-SD02V	680-20478-14	sediment	X	X
REF2-SD03V	680-20478-15	sediment	X	X
REF2-SD04V	680-20478-16	sediment	X	X
REF2-SD04VMS	680-20478-16S	sediment	X	X
REF2-SD04VMSD	680-20478-16SD	sediment	X	X
REF2-SD04VD	680-20478-17	sediment	X	X
REF1-SD05V	680-20478-18	sediment	X	X
REF1-SD06V	680-20478-19	sediment	X	X
45B-SD02V	680-20478-2	sediment	X	X
REF3-SD01V	680-20478-20	sediment	X	X
REF3-SD01VD	680-20478-21	sediment	X	X
REF3-SD02V	680-20478-22	sediment	X	X
45B-SD03V	680-20478-3	sediment	X	X
45B-SD04V	680-20478-4	sediment	X	X
45B-SD05V	680-20478-5	sediment	X	X
45B-SD06V	680-20478-6	sediment	X	X
REF1-SD01V	680-20478-7	sediment	X	X
REF1-SD02V	680-20478-8	sediment	X	X
REF1-SD03V	680-20478-9	sediment	X	X
45B-ER01V	680-20478-23	water	X	X
45B-FB01V	680-20478-24	water	X	X

The field quality control samples provided with this SDG included REF2-SD04VD-field duplicate of sample REF2-SD04V; REF3-SD01VD-field duplicate of sample REF3-SD01V; 45B-ER01V-rinse blank and 45B-FB01V-field blank. The samples were evaluated based on the following criteria:

- Data Completeness *
- Technical Holding Times *
- Initial/Continuing Calibrations *
- CRDL Standards *
- Interference Check Sample *
- Blanks
- Laboratory Control Samples *
- Matrix Spike Recoveries *
- Matrix Duplicate RPDs *
- Post Digestion Spike Recoveries *
- Serial Dilutions *
- Field Duplicates
- Identification/Quantitation
- Reporting Limits *

- - indicates that no qualifications were required based on this criteria

Overall Evaluation of Data/Potential Usability Issues

Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. If an issue is not addressed there were no actions required based on unmet quality criteria.

Major Problems

Metals

The field duplicate pair of samples REF3-SD01V and REF3-SD01VD exhibited non-compliant reproducibility for lead (absolute difference is 2.93, which is greater than +/- 4X the CRDL for results < 5X the CRDL). Region II guidelines requires rejection of detected results \geq MDL but < 5X CRDL in the field sample and its duplicate. Therefore, the reported result for lead in the field sample was rejected, R. The result reported in the field duplicate sample was greater than 5X the CRDL and therefore, was not rejected.

Minor Problems

Issues requiring qualification of the analytical data were found in the validation of this SDG. A summary of these issues is presented in the following paragraphs. All results qualified as estimated J/UJ should be considered usable but estimated.

Metals

The preparation blank exhibited contamination for zinc for which qualification of the data was required.

AR1260 & Metals

Many of the samples exhibited %solids less than 50% but greater than 10%. Reported results in these samples were qualified as estimated J/UJ based on Region II guidelines.

Specific Evaluation of Data

Data Completeness

Resubmissions were required for the Form 10s submitted for the MS and MSD pair for the PCB data package. Errors were noted in the reporting of the two column quantitation results on these forms and the moisture results were not taken into consideration in the calculation of the results on the Form 10s or in the raw data. The LIMS forms (form 3s and form 1s) were reported correctly. The laboratory resubmitted corrected Form 10s and raw data for the MS and MSD. No other resubmissions were required. A copy of the e-mail correspondence is included in the validation worksheets.

Technical Holding Times

According to chain of custody records, sampling was performed on 9/20-21/06 and samples were received at the laboratory 9/22/06. All sample preparation and analysis was performed within Region II holding time requirements.

Metals

Blanks

In establishing action limits for the metals analytes, the highest concentration reported in associated blanks is used. This is the concentration noted in the following table tabulating blank contamination. If an analyte was detected in a blank but no action was required, it is not listed in the following table. Qualifications were required due to preparation blank contamination.

Blank ID	Analyte	Concentration	Action Level
PB1	zinc	0.422200J mg/Kg	RL

Concentration noted must be adjusted for sample aliquot and moisture content when comparing to associated field samples.

Associated samples and required qualifications are noted in the following table.

Sample ID	Analyte	Q Flag
REF2-SD01V, REF2-SD03V, REF2-SD04V, REF2-SD04VD, REF2-SD05V, REF2-SD06V	lead	U at RL

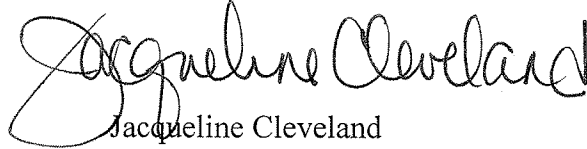
Identification/Quantitation

AR1260 and Metals

Many of the samples in this SDG exhibited %Solids values <50% but greater than 10%. Region II requires that all results be qualified as estimated J/UJ. Reported results for AR1260 and the metals analytes were qualified as estimated in samples REF1-SD01V, REF1-SD05V, REF2-SD01V, REF2-SD02V and REF2-SD06V.

A summary of qualifications required is provided on the following page. Please do not hesitate to contact DataQual ES with any questions regarding this validation report.

Sincerely,



Jacqueline Cleveland
Vice-President

Summary of Data Qualifications

AR1260

Sample ID	Compound	Results	Q Flag
REF1-SD01V, REF1-SD05V, REF2-SD01V, REF2-SD02V and REF2-SD06V	AR1260	+/-	J/UJ

Metals

Sample ID	Analyte	Results	Q Flag
REF2-SD01V, REF2-SD03V, REF2-SD04V, REF2-SD04VD, REF2-SD05V, REF2-SD06V	zinc	+B	U at RL
REF3-SD01V	lead	+	R
REF3-SD01V, REF3-SD01VD	zinc	+	J
REF1-SD01V, REF1-SD05V, REF2-SD01V, REF2-SD02V and REF2-SD06V	all analytes	+/-	J/UJ

Glossary of Qualification Flags and Abbreviations

Qualification Flags (Q-Flags)

U	not detected above the reported sample quantitation limit
J	estimated value
UJ	reported quantitation limit is qualified as estimated
R	result is rejected; the presence or absence of the analyte cannot be verified
D	result value is based on dilution analysis result
NJ	analyte has been tentatively identified, estimated value
J-	analyte present, biased low
UL	not detected, quantitation limit is probably higher
J+	analyte present, biased high
Q	estimated dioxin/furan concentration
I	interferences present which may cause the results to be biased high

Method Blank Qualification Flags (Q-Flags)

NA	The sample result for the blank contaminant is greater than the sample CRDL and is greater than the action level. The sample result for the blank contaminant is not qualified with any blank qualifiers.
U OR RL	The sample result for the blank contaminant is less than or greater than the sample RL and is less than the action level. The sample result for the blank contaminant is qualified as U or RL depending on the concentration of the result.

General Abbreviations

IDL	Instrument Detection Limit
MDL	Method Detection Limit
RL	Contract Required Reporting Limit
+	positive result
-	non-detect result

SEVERN TRENT - PITTSBURGH SDG C7E0220126

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: C7E220146
Fraction: Inorganic
Matrix: Soil
Report Date: 7/20/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. Two matrix spike sample/matrix spike duplicates were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for select metals: antimony, copper, lead, mercury, and zinc. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

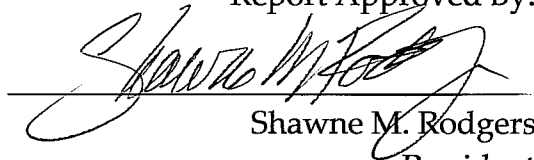
All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

-
- X • Data Completeness
 - X • Chain of Custody Documentation
 - X • Holding Times
 - X • Initial and Continuing Calibrations
 - X • ICP Interference Check Sample Results
 - X • Laboratory and Field Blank Analysis Results
 - X • Matrix Spike Recoveries and Reproducibility
 - X • Laboratory Duplicate Analysis Results
 - X • ICP Serial Dilution Results
 - X • Field Duplicate Analysis Results
 - X • Laboratory Control Sample Results
 - GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
 - X • Qualitative Identification
 - X • Quantitation/Reporting Limits
-

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:


Shawne M. Rodgers
President


Date

1.0 DATA COMPLETENESS

All criteria were met. No qualifiers were applied.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

Positive results for mercury for samples 2B-SS01, 2B-SS02, 2B-SS03, 2B-SS04, 2B-SS014D, 2B-SS05, 2B-SS06, 2B-SS07, 2B-SS08, 2B-SS09, 2B-SS10, 2B-SS11, 2B-SS12, 2B-SS13, 2B-SS14, 2B-SS14D, 2B-SS15, 2B-SS16, 2B-SS17, 2B-SS18, and 2B-SS19 should be considered biased high quantitative estimates and may be lower than reported. The associated matrix spike recovery was above the acceptance limit for this analyte. The high recovery indicates the presence of interferences for mercury for samples of similar matrix. The positive results have been marked with "J" qualifiers to indicate that they are biased high quantitative estimates.

8.0 LABORATORY DUPLICATE RESULTS

All criteria were met. No qualifiers were applied.

9.0 ICP SERIAL DILUTION RESULTS

The positive results for antimony, copper, and zinc should be considered quantitative estimates. The ICP serial dilution criterion was exceeded for these elements. The lack of precision may be due to interferences in samples of similar matrix. The positive results for these metals have been marked with "J" qualifiers to indicate that they are quantitative estimates.

10.0 FIELD DUPLICATE RESULTS

Duplicate samples 2B-SS04 and 2B-SS04D, 2B-SS14 and 2B-SS14D, and 2B-SS34 and 2B-SS34D were submitted to the laboratory evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Tables 2 through 4. The Region II criteria were met for all analytes, except for lead in samples 2B-SS04 and 2B-SS04D, and 2B-SS34 and 2B-SS34D. The results for lead for the duplicate samples should be considered quantitative estimates, and have been marked "J".

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

14.0 *QUANTITATION/REPORTING LIMITS*

Positive results and quantitation limits for all inorganic analytes for samples that were not previously qualified for other criteria, should be considered biased low quantitative estimates, and may be higher than reported. The percent solids for these sediment samples were less than 50 percent. The positive results have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates. The quantitation limits have been marked "UJ".

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 1631A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected May 2007
Severn Trent Sample Delivery Group C7E220126

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	TMET
2B-SS01	C7E220126 1	5/18/2007	Soil	X
2B-SS02	C7E220126 2	5/18/2007	Soil	X
2B-SS03	C7E220126 3	5/18/2007	Soil	X
2B-SS04	C7E220126 4	5/18/2007	Soil	X
2B-SS04D	C7E220126 5	5/18/2007	Soil	X
2B-SS05	C7E220126 6	5/18/2007	Soil	X
2B-SS06	C7E220126 7	5/18/2007	Soil	X
2B-SS07	C7E220126 8	5/18/2007	Soil	X
2B-SS08	C7E220126 9	5/18/2007	Soil	X
2B-SS09	C7E220126 10	5/18/2007	Soil	X
2B-SS10	C7E220126 11	5/18/2007	Soil	X
2B-SS11	C7E220126 12	5/18/2007	Soil	X
2B-SS12	C7E220126 13	5/18/2007	Soil	X
2B-SS13	C7E220126 14	5/18/2007	Soil	X
2B-SS14	C7E220126 15	5/18/2007	Soil	X
2B-SS14D	C7E220126 16	5/18/2007	Soil	X
2B-SS15	C7E220126 17	5/18/2007	Soil	X
2B-SS16	C7E220126 18	5/18/2007	Soil	X
2B-SS17	C7E220126 19	5/18/2007	Soil	X
2B-SS18	C7E220126 20	5/18/2007	Soil	X
2B-SS19	C7E220126 21	5/18/2007	Soil	X
2B-SS20	C7E220126 22	5/18/2007	Soil	X
2B-SS21	C7E220126 23	5/18/2007	Soil	X
2B-SS22	C7E220126 24	5/18/2007	Soil	X
2B-SS23	C7E220126 25	5/18/2007	Soil	X
2B-SS25	C7E220126 26	5/18/2007	Soil	X
2B-SS26	C7E220126 27	5/18/2007	Soil	X
2B-SS27	C7E220126 28	5/18/2007	Soil	X
2B-SS28	C7E220126 29	5/18/2007	Soil	X
2B-SS29	C7E220126 30	5/18/2007	Soil	X
2B-SS30	C7E220126 31	5/18/2007	Soil	X
2B-SS31	C7E220126 32	5/18/2007	Soil	X
2B-SS32	C7E220126 33	5/18/2007	Soil	X
2B-SS33	C7E220126 34	5/18/2007	Soil	X
2B-SS34	C7E220126 35	5/18/2007	Soil	X
2B-SS34D	C7E220126 36	5/18/2007	Soil	X
2B-SS35	C7E220126 37	5/18/2007	Soil	X
2B-SS36	C7E220126 38	5/18/2007	Soil	X
2B-SS37	C7E220126 39	5/18/2007	Soil	X
2B-SS38	C7E220126 40	5/18/2007	Soil	X

TMET Total Metals: Sb, Cu, Pb, Hg, Zn

Table 2 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-SS04 and 2B-SS04D

Analyte	2B-SS04 (mg/Kg)		2B-SS04D (mg/Kg)		RPD	FOOT NOTES
Copper	219	J	274	J	22.3	Already Qualified
Lead	3550		1580		76.8	*
Antimony	1.8	J	5.2	J	97.1	Already Qualified
Zinc	345.00	J	644	J	60.5	Already Qualified
Mercury	0.48	J	0.36	J	28.6	Already Qualified

Table 3 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-SS14 and 2B-SS14D

Analyte	2B-SS14 (mg/Kg)		2B-SS14D (mg/Kg)		RPD	FOOT NOTES
Copper	74.1	J	73.4	J	0.9	
Lead	795		667		17.5	
Antimony	0.76	J	0.99	J	26.3	
Zinc	179	J	154	J	15.0	
Mercury	4.2	J	4.1	J	2.4	

Table 4 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-SS34 and 2B-SS34D

Analyte	2B-SS34 (mg/Kg)		2B-SS34D (mg/Kg)		RPD	FOOT NOTES
Copper	8130	J	8530	J	4.8	*
Lead	637		1040		48.1	
Antimony	0.73	J	1.0	J	31.2	
Zinc	2710	J	1380	J	65.0	
Mercury	0.20		0.25		22.2	

SEVERN TRENT - SEATTLE SDG 580-5970-1

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 580-5970-1
Fraction: Inorganic
Matrix: Soil
Report Date: 8/3/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. Five field duplicates and three matrix spike sample/matrix spike duplicates were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for select metals: antimony, copper, lead, mercury, and zinc. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

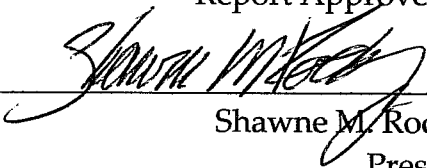
All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

-
- X • Data Completeness
 - X • Chain of Custody Documentation
 - X • Holding Times
 - X • Initial and Continuing Calibrations
 - X • ICP Interference Check Sample Results
 - X • Laboratory and Field Blank Analysis Results
 - X • Matrix Spike Recoveries and Reproducibility
 - X • Laboratory Duplicate Analysis Results
 - X • ICP Serial Dilution Results
 - X • Field Duplicate Analysis Results
 - X • Laboratory Control Sample Results
 - GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
 - X • Qualitative Identification
 - X • Quantitation/Reporting Limits
-

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:


Shawne M. Rodgers
President


Date

1.0 DATA COMPLETENESS

All criteria were met. No qualifiers were applied.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

The following positive results reported are considered to be nondetect due to the presence of these analytes in the associated continuing calibration blanks and/or preparation blanks. The analytes were detected in the associated continuing calibration blanks and/or preparation blanks at levels less than the quantitation limit, indicating the possibility of a false positive at this level. The affected results for these samples are less than the quantitation limit. Replacing the sample result with the quantitation limit and marking it "U" has indicated this.

Analyte	Affected Samples
Antimony	2B-SS46, 2B-SS47, 2B-SS48, 2B-SS49, 2B-SS50, 2B-REF-SB01-01, 2B-REF-SB02-01, 2B-REF-SB03-01, 2B-REF-SB04-01, 2B-REF-SB04-01D, 2B-REF-SB05-01, 2B-REF-SB06-01, 2B-REF-SS01, 2B-REF-SS02, 2B-REF-SS03, 2B-REF-SS04D, 2B-REF-SS05, 2B-REF-SS06
Mercury	2B-REF-SB01-01, 2B-REF-SB04-01, 2B-REF-SB05-01

7.0

MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

The following positive results for should be considered biased high quantitative estimates and may be lower than reported. The associated matrix spike recoveries were above the acceptance limit for these analytes. The high recoveries indicate the presence of interferences for samples of similar matrix. The positive results have been marked with "J" qualifiers to indicate that they are biased high quantitative estimates.

Analyte	Affected Samples
Copper	2B-REF-SS04, 2B-REF-SS04D, 2B-REF-SS05, 2B-REF-SS06
Lead	2B-REF-SS04, 2B-REF-SS04D, 2B-REF-SS05, 2B-REF-SS06
Zinc	2B-REF-SS04, 2B-REF-SS04D, 2B-REF-SS05, 2B-REF-SS06
Mercury	2B-SB01-01, 2B-SB02-01, 2B-SB04-01, 2B-SB04-01D, 2B-SB06-01, 2B-SB07-01, 2B-SB08-01, 2B-SB09-01, 2B-SB10-01

8.0

LABORATORY DUPLICATE RESULTS

All criteria were met. No qualifiers were applied.

9.0 ICP SERIAL DILUTION RESULTS

All criteria were met. No qualifiers were applied.

10.0 FIELD DUPLICATE RESULTS

Duplicate samples 2B-SS44 and 2B-SS44D, 2B-SS24 and 2B-SS24D, 2B-REF-SB04-01 and 2B-REF-SB04-01D, 2B-SB04-01 and 2B-SB04-01D, and 2B-REF-SS04 and 2B-REF-SS04D were submitted to the laboratory evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Tables 2 through 6. The Region II criteria were met for all analytes, except for copper for samples 2B-SB04-01 and 2B-SB04-01D. The results for copper for the duplicate samples should be considered quantitative estimates, and have been marked "J".

11.0 LABORATORY CONTROL SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

12.0 GFAA POST-DIGESTION SPIKE/DUPLICATE BURN

This parameter is not applicable to the analyses performed.

13.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

14.0 QUANTITATION/REPORTING LIMITS

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected May 2007
Severn Trent Sample Delivery Group 580-5970-1

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED TMET1
2B-SS39	580-5970- 1	5/18/2007	Soil	X
2B-SS40	580-5970- 2	5/18/2007	Soil	X
2B-SS41	580-5970- 3	5/18/2007	Soil	X
2B-SS42	580-5970- 4	5/18/2007	Soil	X
2B-SS43	580-5970- 5	5/18/2007	Soil	X
2B-SS44	580-5970- 6	5/18/2007	Soil	X
2B-SS44D	580-5970- 7	5/18/2007	Soil	X
2B-SS24	580-5970- 8	5/18/2007	Soil	X
2B-SS24D	580-5970- 9	5/18/2007	Soil	X
2B-SS45	580-5970- 10	5/18/2007	Soil	X
2B-SS46	580-5970- 11	5/18/2007	Soil	X
2B-SS47	580-5970- 12	5/18/2007	Soil	X
2B-SS48	580-5970- 13	5/18/2007	Soil	X
2B-SS49	580-5970- 14	5/18/2007	Soil	X
2B-SS50	580-5970- 15	5/18/2007	Soil	X
2B-REF-SB01-01	580-5970- 16	5/20/2007	Soil	X
2B-REF-SB02-01	580-5970- 17	5/20/2007	Soil	X
2B-REF-SB03-01	580-5970- 18	5/20/2007	Soil	X
2B-REF-SB04-01	580-5970- 19	5/20/2007	Soil	X
2B-REF-SB04-01D	580-5970- 20	5/20/2007	Soil	X
2B-REF-SB05-01	580-5970- 21	5/20/2007	Soil	X
2B-REF-SB06-01	580-5970- 22	5/20/2007	Soil	X
2B-SB01-01	580-5970- 23	5/18/2007	Soil	X
2B-SB02-01	580-5970- 24	5/18/2007	Soil	X
2B-SB04-01	580-5970- 25	5/18/2007	Soil	X
2B-SB04-01D	580-5970- 26	5/18/2007	Soil	X
2B-SB06-01	580-5970- 27	5/18/2007	Soil	X
2B-SB07-01	580-5970- 28	5/18/2007	Soil	X
2B-SB08-01	580-5970- 29	5/18/2007	Soil	X
2B-SB09-01	580-5970- 30	5/18/2007	Soil	X
2B-SB10-01	580-5970- 31	5/18/2007	Soil	X
2B-REF-SS01	580-5970- 32	5/18/2007	Soil	X
2B-REF-SS02	580-5970- 33	5/18/2007	Soil	X
2B-REF-SS03	580-5970- 34	5/18/2007	Soil	X
2B-REF-SS04	580-5970- 35	5/18/2007	Soil	X
2B-REF-SS04D	580-5970- 36	5/18/2007	Soil	X
2B-REF-SS05	580-5970- 37	5/18/2007	Soil	X
2B-REF-SS06	580-5970- 38	5/18/2007	Soil	X

TMET1 Total Metals: Antimony, Copper, Lead, Mercury, Zinc

Table 2 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-SS44 and 2B-SS44D

Analyte	2B-SS44 (mg/Kg)	2B-SS44D (mg/Kg)	RPD	FOOT NOTES
Antimony	8.7	8.2	5.9	
Copper	200	190	5.1	
Lead	290	310	6.7	
Mercury	0.43	0.46	6.7	
Zinc	1100	930	16.7	

Table 3 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-SS24 and 2B-SS24D

Analyte	2B-SS24 (mg/Kg)	2B-SS24D (mg/Kg)	RPD	FOOT NOTES
Antimony	1.1	1.0	9.5	
Copper	130	99	27.1	
Lead	140	130	7.4	
Mercury	0.16	0.18	11.8	
Zinc	260	210	21.3	

Table 4 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-REF-SB04-01 and 2B-REF-SB04-01D

Analyte	2B-REF-SB04-01 (mg/Kg)	2B-REF-SB04-01D (mg/Kg)	RPD	FOOT NOTES
Copper	63	84	28.6	
Lead	2.5	3	18.2	
Mercury	ND	0.023	NC	
Zinc	31	36	14.9	

Table 5 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-SB04-01 and 2B-SB04-01D

Analyte	2B-SB04-01 (mg/Kg)		2B-SB04-01D (mg/Kg)		RPD	FOOT NOTES
Antimony	36		33		8.7	
Copper	270	J	1000	J	115.0	*
Lead	1300		1400		7.4	
Mercury	0.68	J	0.94	J	32.1	
Zinc	590		3800		146.2	

Table 6 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-REF-SS04 and 2B-REF-SS04D

Analyte	2B-REF-SS04 (mg/Kg)		2B-REF-SS04D (mg/Kg)		RPD	FOOT NOTES
Antimony	0.74		ND		NC	Already Qualified
Copper	100	J	100	J	0.0	
Lead	29	J	5	J	145.2	
Mercury	0.038		0.044		14.6	
Zinc	49	J	47	J	4.2	

SEVERN TRENT - SAVANNAH SDG SWMU26880-1

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 26880-1
Fraction: Inorganic
Matrix: Soil
Report Date: 7/11/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. One field duplicate sample and one matrix spike sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: cadmium, copper, lead, antimony, tin, zinc, and nickel, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.


All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

-
- X • Data Completeness
 - X • Chain of Custody Documentation
 - X • Holding Times
 - X • Initial and Continuing Calibrations
 - X • ICP Interference Check Sample Results
 - X • Laboratory and Field Blank Analysis Results
 - X • Matrix Spike Recoveries and Reproducibility
 - X • Laboratory Duplicate Analysis Results
 - X • ICP Serial Dilution Results
 - X • Field Duplicate Analysis Results
 - X • Laboratory Control Sample Results
 - GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
 - X • Qualitative Identification
 - X • Quantitation/Reporting Limits
-

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:


Shawne M. Rodgers
President

7/11/2007

Date

1.0 DATA COMPLETENESS

Zinc exceeded percent recovery criteria for the interference check standard analysis; however, this was not noted in the case narrative. The laboratory was contacted and provided the revised case narrative indicating that there was trace zinc contamination as determined by the vendor in the interference check standard solution resulting in the criteria exceedance.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 *MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY*

The positive results reported for copper for the samples should be considered biased high quantitative estimates, and may be lower than reported. A high recovery for this analyte was obtained for the associated matrix spike analysis. The high recovery indicates the presence of interferences in samples of similar matrix. The positive results for this analyte have been marked with "J" qualifiers to indicate that they are biased high quantitative estimates.

The positive results reported for lead for all samples should be considered biased low quantitative estimates, and may be higher than reported. A low recovery for this analyte was obtained for the associated matrix spike analysis. The low recovery indicates the presence of interferences in samples of similar matrix. The positive results for lead have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates.

8.0 *LABORATORY DUPLICATE RESULTS*

All criteria were met. No qualifiers were applied.

9.0 *ICP SERIAL DILUTION RESULTS*

The positive results for zinc should be considered quantitative estimates. The ICP serial dilution criterion was exceeded for this element. The lack of precision may be due to interferences in samples of similar matrix. The positive results for this metal have been marked with "J" qualifiers to indicate that they are quantitative estimates.

10.0 *FIELD DUPLICATE RESULTS*

Duplicate samples 2B-REF-EWSD04 and 2B-REF-EWSD04D were submitted to the laboratory to evaluate sampling and analytical precision

for those analytes determined to be present. Results for these duplicate samples are presented in Table 2. The Region II criteria were met for the field duplicate samples.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

14.0 *QUANTITATION/REPORTING LIMITS*

Positive results and quantitation limits for mercury for samples 2B-REF-EWSD02, 2B-EWSD05, and 2B-EWSD06 should be considered biased low quantitative estimates, and may be higher than reported. The percent solids for these samples were less than 50 percent. The positive results have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates. The quantitation limits have been marked "UJ".

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6010B, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected May 2007
Severn Trent Sample Delivery Group 26880-1

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED	
				TMET	Hg
2B-REF-EWSD04	680-26880-10	5/22/2007	Soil	X	X
2B-REF-EWSD04D	680-26880-11	5/22/2007	Soil	X	X
2B-REF-EWSD05	680-26880-12	5/22/2007	Soil	X	X
2B-REF-EWSD06	680-26880-13	5/22/2007	Soil	X	X
2B-EWSD01	680-26880-14	5/22/2007	Soil	X	X
2B-EWSD02	680-26880-15	5/22/2007	Soil	X	X
2B-EWSD03	680-26880-16	5/22/2007	Soil	X	X
2B-EWSD05	680-26880-19	5/19/2007	Soil	X	X
2B-EWSD06	680-26880-20	5/19/2007	Soil	X	X
2B-EWSD07	680-26880-21	5/19/2007	Soil	X	X
2B-REF-EWSD02	680-26880-8	5/22/2007	Soil	X	X
2B-REF-EWSD03	680-26880-9	5/22/2007	Soil	X	X

TMET Total Metals: Copper, Lead, Zinc
Hg Mercury

Table 2 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-REF-EWSD04 and 2B-REF-EWSD04D

Analyte	2B-REF-EWSD04 (mg/Kg)		2B-REF-EWSD04D (mg/Kg)		RPD	FOOT NOTES
Copper	51	J	46	J	10.3	
Lead	8.3	J	5.0	J	49.6	
Mercury	0.035		0.046		27.2	
Zinc	70	J	54	J	25.8	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

NE Not detected.

SEVERN TRENT - SAVANNAH SDG SWMU26880-2

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: 26880-2
Fraction: Inorganic
Matrix: Soil
Report Date: 7/11/2007

This analytical quality assurance report is based upon a review of analytical data generated for soil samples. One field duplicate sample and one matrix spike sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: cadmium, copper, lead, antimony, tin, zinc, and nickel, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

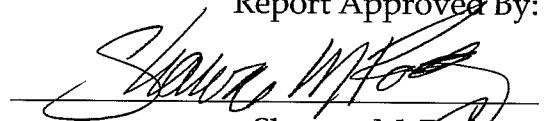
All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.


-
- X • Data Completeness
 - X • Chain of Custody Documentation
 - X • Holding Times
 - X • Initial and Continuing Calibrations
 - X • ICP Interference Check Sample Results
 - X • Laboratory and Field Blank Analysis Results
 - X • Matrix Spike Recoveries and Reproducibility
 - X • Laboratory Duplicate Analysis Results
 - X • ICP Serial Dilution Results
 - X • Field Duplicate Analysis Results
 - X • Laboratory Control Sample Results
 - GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
 - X • Qualitative Identification
 - X • Quantitation/Reporting Limits
-

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:


Shawne M. Rodgers
President


Date

1.0 DATA COMPLETENESS

Zinc exceeded percent recovery criteria for the interference check standard analysis; however, this was not noted in the case narrative. The laboratory was contacted and provided the revised case narrative indicating that there was trace zinc contamination as determined by the vendor in the interference check standard solution resulting in the criteria exceedance.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 ***MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY***

The positive results reported for copper for the samples 2B-EWSD08, 2B-EWSD09, 2B-EWSD15, 2B-EWSD23, and 2B-EWSD24 should be considered biased high quantitative estimates, and may be lower than reported. A high recovery for this analyte was obtained for the associated matrix spike analysis. The high recovery indicates the presence of interferences in samples of similar matrix. The positive results for this analyte have been marked with "J" qualifiers to indicate that they are biased high quantitative estimates.

8.0 ***LABORATORY DUPLICATE RESULTS***

All criteria were met. No qualifiers were applied.

9.0 ***ICP SERIAL DILUTION RESULTS***

All criteria were met. No qualifiers were applied.

10.0 ***FIELD DUPLICATE RESULTS***

Duplicate samples 2B-EWSD04 and 2B-EWSD04D, and 2B-EWSD14 and 2B-EWSD14D were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Tables 2 and 3, respectively. The Region II criteria were met for the field duplicate samples.

11.0 ***LABORATORY CONTROL SAMPLE RESULTS***

All criteria were met. No qualifiers were applied.

12.0 GFAA POST-DIGESTION SPIKE/DUPLICATE BURN

This parameter is not applicable to the analyses performed.

13.0 QUALITATIVE IDENTIFICATION

All criteria were met. No qualifiers were applied.

14.0 QUANTITATION/REPORTING LIMITS

Positive results and quantitation limits for metals for samples 2B-EWSD04, 2B-EWSD04D, 2B-EWSD10, 2B-EWSD11, 2B-EWSD12, 2B-EWSD13, 2B-EWSD14, 2B-EWSD14D, 2B-EWSD18, 2B-EWSD19, 2B-EWSD20, 2B-EWSD21, 2B-EWSD22, and 2B-REF-EWSD01 should be considered biased low quantitative estimates, and may be higher than reported. The percent solids for these samples were less than 50 percent. The positive results have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates. The quantitation limits have been marked "UJ".

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6010B, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected May 2007
Severn Trent Sample Delivery Group 26880-2

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED	
				TMET	Hg
2B-EWSD04	680-26880-17	5/22/2007	Soil	X	X
2B-EWSD04D	680-26880-18	5/22/2007	Soil	X	X
2B-EWSD08	680-26880-22	5/22/2007	Soil	X	X
2B-EWSD09	680-26880-23	5/22/2007	Soil	X	X
2B-EWSD10	680-26880-24	5/22/2007	Soil	X	X
2B-EWSD11	680-26880-25	5/22/2007	Soil	X	X
2B-EWSD12	680-26880-26	5/22/2007	Soil	X	X
2B-EWSD13	680-26880-27	5/22/2007	Soil	X	X
2B-EWSD14	680-26880-28	5/22/2007	Soil	X	X
2B-EWSD14D	680-26880-29	5/22/2007	Soil	X	X
2B-EWSD15	680-26880-30	5/22/2007	Soil	X	X
2B-EWSD16	680-26880-31	5/22/2007	Soil	X	X
2B-EWSD18	680-26880-32	5/22/2007	Soil	X	X
2B-EWSD19	680-26880-33	5/22/2007	Soil	X	X
2B-EWSD20	680-26880-34	5/22/2007	Soil	X	X
2B-EWSD21	680-26880-35	5/22/2007	Soil	X	X
2B-EWSD22	680-26880-36	5/22/2007	Soil	X	X
2B-EWSD23	680-26880-37	5/22/2007	Soil	X	X
2B-EWSD24	680-26880-38	5/22/2007	Soil	X	X
2B-REF-EWSD01	680-26880-39	5/22/2007	Soil	X	X

TMET Total Metals: Copper, Lead, Zinc
Hg Mercury

Table 2 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-EWSD04 and 2B-EWSD04D

Analyte	2B-EWSD04 (mg/Kg)		2B-EWSD04D (mg/Kg)		RPD	FOOT NOTES
Copper	21	J	19	J	10.0	
Lead	3.4	J	3.6	J	5.7	
Mercury	0.030	J	0.026	J	14.3	
Zinc	18	J	17	J	5.7	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

NE Not detected.

Table 3 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-EWSD14 and 2B-EWSD14D

Analyte	2B-EWSD14 (mg/Kg)		2B-EWSD14D (mg/Kg)		RPD	FOOT NOTES
Copper	84	J	95	J	12.3	
Lead	23	J	26	J	12.2	
Mercury	0.099	J	0.095	J	4.1	
Zinc	62	J	65	J	4.7	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

NE Not detected.

SEVERN TRENT - SAVANNAH SDG SWMU27044

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: SWMU27044
Fraction: Inorganic
Matrix: Soil
Report Date: 7/26/2007

This analytical quality assurance report is based upon a review of analytical data generated for sediment samples. One matrix spike sample/matrix spike duplicate were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for acid volatile sulfide and simultaneously extracted metals. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

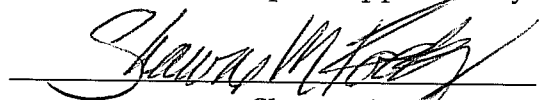
All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

-
- X • Data Completeness
 - X • Chain of Custody Documentation
 - X • Holding Times
 - X • Initial and Continuing Calibrations
 - X • ICP Interference Check Sample Results
 - X • Laboratory and Field Blank Analysis Results
 - X • Matrix Spike Recoveries and Reproducibility
 - X • Laboratory Duplicate Analysis Results
 - X • ICP Serial Dilution Results
 - X • Field Duplicate Analysis Results
 - X • Laboratory Control Sample Results
 - GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
 - X • Qualitative Identification
 - X • Quantitation/Reporting Limits
-

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:


Shawne M. Rodgers
President


Date

1.0 DATA COMPLETENESS

All criteria were met. No qualifiers were applied.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

All criteria were met. No qualifiers were applied.

8.0 *LABORATORY DUPLICATE RESULTS*

All criteria were met. No qualifiers were applied.

9.0 *ICP SERIAL DILUTION RESULTS*

The positive results for lead and zinc should be considered quantitative estimates. The ICP serial dilution criterion was exceeded for these elements. The lack of precision may be due to interferences in samples of similar matrix. The positive results for these metals have been marked with "J" qualifiers to indicate that they are quantitative estimates.

10.0 *FIELD DUPLICATE RESULTS*

There were no field duplicate samples submitted with this SDG.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

Positive results and quantitation limits for all inorganic analytes for samples 2B-EWSD-04, 2B-EWSD-12, 2B-EWSD-15, 2B-EWSD-18, 2B-EWSD-20, 2B-REF-EWSD-01, and 2B-REF-EWSD-02 that were not previously qualified for other criteria, should be considered biased low quantitative estimates, and may be higher than reported. The percent solids for these sediment samples were less than 50 percent. The positive results have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates. The quantitation limits have been marked "UJ".

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Soil Samples Collected May 2007
Severn Trent Sample Delivery Group SWMU27044

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED MISC1
2B-EWSD-04	680-27044-	16 5/24/2007	Soil	X
2B-EWSD-09	680-27044-	17 5/24/2007	Soil	X
2B-EWSD-12	680-27044-	18 5/24/2007	Soil	X
2B-EWSD-15	680-27044-	19 5/24/2007	Soil	X
2B-EWSD-16	680-27044-	20 5/24/2007	Soil	X
2B-EWSD-18	680-27044-	21 5/24/2007	Soil	X
2B-EWSD-20	680-27044-	22 5/24/2007	Soil	X
2B-EWSD-24	680-27044-	23 5/24/2007	Soil	X
2B-REF-EWSD-01	680-27044-	24 5/24/2007	Soil	X
2B-REF-EWSD-02	680-27044-	25 5/24/2007	Soil	X

MISC1 Acid Volatile Sulfide/Simultaneously Extracted Metals

SEVERN TRENT - SAVANNAH SDG SWMU26980

Project: Aquatic BERA, SWMU 1 and 2, CTO-108
Laboratory: Severn Trent Laboratories
Sample Delivery Group: SWMU26980
Fraction: Inorganic
Matrix: Solid
Report Date: 7/24/2007

This analytical quality assurance report is based upon a review of analytical data generated for solid samples. One field duplicate sample and one matrix spike sample were submitted with the samples for this Sample Delivery Group. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for select total metals. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

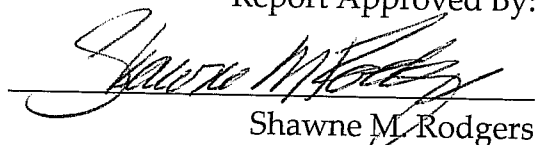
All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.


-
- X • Data Completeness
 - X • Chain of Custody Documentation
 - X • Holding Times
 - X • Initial and Continuing Calibrations
 - X • ICP Interference Check Sample Results
 - X • Laboratory and Field Blank Analysis Results
 - X • Matrix Spike Recoveries and Reproducibility
 - X • Laboratory Duplicate Analysis Results
 - X • ICP Serial Dilution Results
 - X • Field Duplicate Analysis Results
 - X • Laboratory Control Sample Results
 - GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
 - X • Qualitative Identification
 - X • Quantitation/Reporting Limits
-

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:


Shawne M. Rodgers
President


Date

1.0 DATA COMPLETENESS

The data package was complete.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

All criteria were met. No qualifiers were applied.

8.0 *LABORATORY DUPLICATE RESULTS*

All criteria were met. No qualifiers were applied.

9.0 *ICP SERIAL DILUTION RESULTS*

All criteria were met. No qualifiers were applied.

10.0 *FIELD DUPLICATE RESULTS*

Duplicate samples 2B-OWSD02 and 2B-OWSD02D were submitted to the laboratory to evaluate sampling and analytical precision for those analytes determined to be present. Results for these duplicate samples are presented in Table 2. The Region II criteria were met for the field duplicate samples.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

Positive results and quantitation limits for metals for samples 2B-OWSD01, 2B-OWSD02, 2B-OWSD02D, and 2B-OWSD03 should be considered biased low quantitative estimates, and may be higher than reported. The percent solids for these samples were less than 50 percent. The positive results have been marked with "J" qualifiers to indicate that they are biased low quantitative estimates. The quantitation limits have been marked "UJ".

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
Aquatic BERA SWMU 1 and 2 (CTO-108)
Samples Collected May 2007
Severn Trent Sample Delivery Group SWMU26980

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED			
				TMET1	TMET2	TMET3	TMET4
2B-ER01	680-26980-	1	5/21/2007	Equipment Rinsate		X	
2B-ER02	680-26980-	2	5/20/2007	Equipment Rinsate	X		
2B-ER03	680-26980-	3	5/21/2007	Equipment Rinsate	X		
2B-FB01	680-26980-	4	5/21/2007	Field Blank		X	
2B-FB02	680-26980-	5	5/21/2007	Field Blank		X	
2B-OWSD01	680-26980-	6	5/22/2007	Sediment			X
2B-OWSD02	680-26980-	7	5/22/2007	Sediment			X
2B-OWSD02D	680-26980-	8	5/22/2007	Sediment			X
2B-OWSD03	680-26980-	9	5/22/2007	Sediment			X
2B-SG01-AG	680-26980-	10	5/22/2007	Sea Grass			X
2B-SG001-WP	680-26980-	11	5/22/2007	Sea Grass			X
2B-SG02-AG	680-26980-	12	5/22/2007	Sea Grass			X
2B-SG02-WP	680-26980-	13	5/22/2007	Sea Grass			X
2B-SG03-AG	680-26980-	14	5/22/2007	Sea Grass			X
2B-SG03-WP	680-26980-	15	5/22/2007	Sea Grass			X
2B-REF-FC01	680-26980-	16	5/21/2007	Fiddler Crab			X
2B-REF-FC02	680-26980-	17	5/21/2007	Fiddler Crab			X
2B-REF-FC03	680-26980-	18	5/21/2007	Fiddler Crab			X
2B-REF-FC04	680-26980-	19	5/21/2007	Fiddler Crab			X
2B-FC01	680-26980-	20	5/22/2007	Fiddler Crab			X
2B-FC02	680-26980-	21	5/22/2007	Fiddler Crab			X
2B-FC03	680-26980-	22	5/22/2007	Fiddler Crab			X
2B-FC04	680-26980-	23	5/22/2007	Fiddler Crab			X
2B-FC05	680-26980-	24	5/22/2007	Fiddler Crab			X
2B-FC06	680-26980-	25	5/22/2007	Fiddler Crab			X
2B-FC07	680-26980-	26	5/22/2007	Fiddler Crab			X
2B-FC08	680-26980-	27	5/22/2007	Fiddler Crab			X

TMET1 Total Metals: Antimony, Copper, Lead, Mercury, Zinc

TMET2 Total Metals: Antimony, Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, Zinc

TMET3 Total Metals: Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, Zinc

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED			
				TMET1	TMET2	TMET3	TMET4
TMET4 Total Metals: Lead and Mercury							

Table 2 Field Duplicate Sample Results for Inorganic Parameters
Duplicate Samples 2B-OWSD02 and 2B-OWSD02D

Analyte	2B-OWSD02 (mg/Kg)		2B-OWSD02D (mg/Kg)		RPD	FOOT NOTES
Arsenic	6.2	J	8.1	J	26.6	
Cadium	ND		0.056	J	NC	
Copper	14	J	16	J	13.3	
Lead	2.6	J	3.2	J	20.7	
Mercury	0.017	J	0.018	J	5.7	
Selenium	0.36	J	0.35	J	2.8	
Zinc	19	J	23	J	19.0	

* Precision criteria exceeded

NC Results not calculated due to already considered estimated or one results was not detected (ND).

NE Not detected.

SEVERN TRENT - SAVANNAH SDG SWMU28224-1

Project: NAPR - SWMUs 1 and 2 (CTO-108)
Laboratory: Test America
Sample Delivery Group: SWMU28224-1
Fraction: Inorganic
Matrix: Soil
Report Date: 5/6/2008

This analytical quality assurance report is based upon a review of analytical data generated for earthworm tissue samples. The sample locations, laboratory identification numbers, sample collection dates, sample matrix, and analyses performed are presented in Table 1.

The samples were analyzed for total metals: cadmium, copper, lead, antimony, tin, zinc, and nickel, and mercury. The sample analyses were performed in accordance with the procedures outlined in the method referenced at the end of this report.

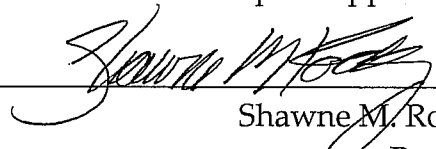
All sample analyses have undergone an analytical quality assurance review to ensure adherence to the required protocols. Results have been validated or qualified according to general guidance provided in "Evaluation of Metals Data for the CLP Program", SOP HW-2, Revision 13, September 2005. The parameters presented on the following page were evaluated.

-
- X • Data Completeness
 - X • Chain of Custody Documentation
 - X • Holding Times
 - X • Initial and Continuing Calibrations
 - X • ICP Interference Check Sample Results
 - X • Laboratory and Field Blank Analysis Results
 - Matrix Spike Recoveries and Reproducibility
 - Laboratory Duplicate Analysis Results
 - ICP Serial Dilution Results
 - Field Duplicate Analysis Results
 - X • Laboratory Control Sample Results
 - GFAA Post-Digestion Spike Recovery/Duplicate Burn Precision
 - X • Qualitative Identification
 - X • Quantitation/Reporting Limits
-

X - Denotes parameter evaluated.

It is recommended that the data only be used according to the qualifiers presented, and discussed in this report. All other data should be considered qualitatively and quantitatively valid as reported by the laboratory, based on the items evaluated.

Report Approved By:


Shawne M. Rodgers
President

5/6/2008
Date

1.0 DATA COMPLETENESS

The data package was complete.

2.0 CHAIN OF CUSTODY DOCUMENTATION

All chain of custody documentation was complete.

3.0 HOLDING TIMES

All criteria were met. No qualifiers were applied.

4.0 INITIAL AND CONTINUING CALIBRATIONS

All criteria were met. No qualifiers were applied.

5.0 ICP INTERFERENCE CHECK SAMPLE RESULTS

All criteria were met. No qualifiers were applied.

6.0 LABORATORY AND FIELD BLANK ANALYSIS RESULTS

All criteria were met. No qualifiers were applied.

7.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES AND REPRODUCIBILITY

The laboratory did not select a site sample to perform matrix spike analyses. Therefore, the associated sample data could not be evaluated

based on this parameter. This should be noted when assessing the sample data.

8.0 *LABORATORY DUPLICATE RESULTS*

The laboratory did not select a site sample to perform laboratory duplicate analyses. Therefore, the associated sample data could not be evaluated based on this parameter. This should be noted when assessing the sample data.

9.0 *ICP SERIAL DILUTION RESULTS*

The laboratory did not select a site sample to perform ICP serial dilution analyses. Therefore, the associated sample data could not be evaluated based on this parameter. This should be noted when assessing the sample data.

10.0 *FIELD DUPLICATE RESULTS*

There were no field duplicate samples submitted with this SDG.

11.0 *LABORATORY CONTROL SAMPLE RESULTS*

All criteria were met. No qualifiers were applied.

12.0 *GFAA POST-DIGESTION SPIKE/DUPLICATE BURN*

This parameter is not applicable to the analyses performed.

13.0 *QUALITATIVE IDENTIFICATION*

All criteria were met. No qualifiers were applied.

All criteria were met. No qualifiers were applied.

METHODOLOGY REFERENCES

Analysis	Reference
Metals	Method 6020, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997
Mercury	Method 7471A, "Test Methods for Evaluating Solid Wastes", SW-846, third edition, Promulgated Updates II, IIA, and III, June 1997

Table 1 Samples For Data Validation Review
NAPR - SWMUs 1 and 2 (CTO-108)
Earthworm Tissue Samples Collected June 2007
Test America Sample Delivery Group SWMU28224-1

SAMPLE I.D.	LABORATORY I.D	DATE COLLECTED	MATRIX	ANALYSES PERFORMED	
				6020	7471A
2B-REF-SB01-01	680-28224-12	7/3/2007	Tissue	X	X
2B-REF-SS04	680-28224-13	7/3/2007	Tissue	X	X
2B-REF-SS05	680-28224-14	7/3/2007	Tissue	X	X
2B-SS04	680-28224-1	7/3/2007	Tissue	X	X
2B-SS05	680-28224-2	7/3/2007	Tissue	X	X
2B-SS10	680-28224-3	7/3/2007	Tissue	X	X
2B-SS13	680-28224-4	7/3/2007	Tissue	X	X
2B-SS14	680-28224-5	7/3/2007	Tissue	X	X
2B-SS31	680-28224-6	7/3/2007	Tissue	X	X
2B-SS33	680-28224-7	7/3/2007	Tissue	X	X
2B-SS34	680-28224-8	7/3/2007	Tissue	X	X
2B-SS41	680-28224-9	7/3/2007	Tissue	X	X
2B-SS44	680-28224-10	7/3/2007	Tissue	X	X
2B-SS49	680-28224-11	7/3/2007	Tissue	X	X

SEVERN TRENT - SAVANNAH SDG 680-23902-1

DataQual

Environmental Services, LLC

Michael Baker, Jr., Inc.
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

October 29, 2008
SDG# SWMU23902-1, Test America-Savannah
NAPR SWMU 45, Step 6 Puerto Rico

Dear Mr. Kimes,

The following Data Validation report is provided as requested for the parameters noted in the table below for SDG # SWMU23902-1. The data validation was performed in accordance with the SW-846 methods utilized by the laboratory and professional judgment. The method in this SDG does not have an applicable Region II checklist SOP (SW-846 method 6020 for select metals (Cu, Pb & Zn). Therefore alternate worksheets were provided. Specific method requirements, Region II flagging conventions and professional judgment were used to validate the metals results. All areas of concern are discussed in the body of the report and a summary of data qualifications is provided.

Sample ID	Lab ID	Matrix	Metals
REF2-VEG-SED01	680-23902-14	soil	X
REF2-VEG-SED02	680-23902-15	soil	X
REF2-VEG-SED03	680-23902-16	soil	X

There were no quality control samples provided with this SDG.

The samples were evaluated based on the following criteria:

- Data Completeness *
- Technical Holding Times *
- Initial/Continuing Calibrations *
- CRDL Standards
- ICSA/ICSAB Standards *
- Blanks *
- Laboratory Control Samples *
- Matrix Spike Recoveries
- Matrix Duplicate RPDs *
- Serial Dilutions *
- Field Duplicates NA
- Identification/Quantitation
- Reporting Limits *

* - indicates that qualifications were not required based on this criteria

Overall Evaluation of Data/Potential Usability Issues

A summary of qualifications applied to the sample results are noted below for the fractions validated. Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. If an issue is not addressed there were no actions required based on unmet quality criteria. When more than one qualifier is associated with a compound/analyte the validator has chosen the qualifier that best indicates possible bias in the results and flagged the data accordingly. However, information regarding all quality control issues is provided in the body of the report and on the qualification summary page.

Metals

The CRDL standard was high for copper. The analyte required qualification in one sample.

The associated MS/MSD exhibited low recoveries for lead and zinc. The analytes were flagged as estimated J/UJ in all samples.

One sample exhibited a %solids value less than 50%. All analytes in this sample were flagged as estimated J/UJ.

Specific Evaluation of Data

Data Completeness

The SDG was received complete and intact. Resubmissions were not required.

Technical Holding Times

According to chain of custody records, sampling was performed on 1/30/07 and samples were received at the laboratory 2/1/07. Sample preparation and analysis was performed within Region II and/or method holding time requirements.

CRDL Standard

Metals

The associated CRDL standard exhibited a high recovery for the analyte copper (145%). All reported positive results greater than 2X the RL required qualification as estimated J. The reported positive result for copper in sample REF2-VEG-SED03 was qualified as estimated J.

Michael Baker, Jr., Inc.
NAPR SWMU45, Puerto Rico
SDG# SWMU23902-1

Page 2
-11-

002

Matrix Spike

Metals

The matrix spikes of sample 45B-VEG-SED01 (an associated sample in the same SDG) exhibited non-compliant recoveries for lead and zinc that required qualification in the field samples. A summary of this non-compliance and affected samples are noted in the following table.

MS/SD	Analytes	Samples	%R	Q Flag
45B-VEG-SED01	lead	all soil samples	45/42	J/UJ
	zinc		29/34	

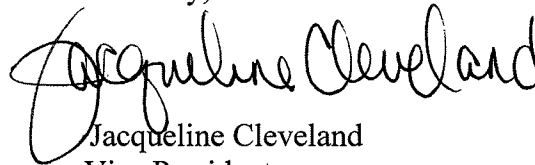
Identification/Quantitation

Metals

Sample REF2-VEG-SED01 exhibited a % solids value that was less than 50% (49%). All reported results in the sample were qualified as estimated J/UJ.

A summary of qualifications required is provided on the following page. Please do not hesitate to contact DataQual ES with any questions regarding this validation report.

Sincerely,



Jacqueline Cleveland
Vice President

Michael Baker, Jr., Inc.
NAPR SWMU45, Puerto Rico
SDG# SWMU23902-1

Page 3

003

Summary of Data Qualifications

Metals

Sample ID	Analyte	Results	Q flag
REF2-VEG-SED03	copper	+	J
all samples	lead	+/-	J/UJ
	zinc		
REF2-VEG-SED01	all analytes	+/-	J/UJ

Glossary of Qualification Flags and Abbreviations

Qualification Flags (Q-Flags)

U	not detected above the reported sample quantitation limit
J	estimated value
UJ	reported quantitation limit is qualified as estimated
-	analyte has been tentatively identified
JN	analyte has been tentatively identified, estimated value
R	result is rejected; the presence or absence of the analyte cannot be verified

Method/Preparation Blank Qualification Flags (Q-Flags)

Organic Methods

NA	The sample result for the blank contaminant is greater than the sample RL and is greater than 5X (10X for common laboratory contaminants) the blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.
U	The sample result for the blank contaminant is greater than the sample RL and is less than 5X (10X for common laboratory contaminants) the blank value.
CRQL	The sample result for the blank contaminant is less than the sample RL and is less than 5X (10X for common laboratory contaminants) the blank value.

Inorganic Methods

ICB/CCB/PB Action:

No Action -	The sample result is greater than the RL and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the RL, result is reported as non-detect at the reporting limit, when the ICB/CCB/PB result is less than the RL.
R -	Sample result is greater than the RL and less than the ICB/CCB value when the ICB/CCB/PB value is greater than the RL.

Glossary of Qualification Flags and Abbreviations

Field QC Blank action:

Note – Use field blanks to qualify data only if field blank results are greater than prep blank results.

Do not use rinsate blank associated with soils to qualify water samples and vice versa.

- No Action - The sample result is greater than the RL and greater than ten times (10X) the blank value.
- U - The sample result is greater than or equal to the MDL but less than or equal to the RL when the field blank result is greater than the RL - result is reported as non-detect at the reporting limit.
- R - Sample result is greater than the RL and less than the field blank value when the field blank result is greater than the RL.
- J - Sample result is greater than the field blank value but less than 10X the field blank value when field blank result is greater than the RL.

General Abbreviations

RL	reporting limit
IDL	instrument detection limit
MDL	method detection limit
CRDL	contract required detection limit
CRQL	contract required quantitation limit
+	positive result
-	non-detect result

METALS
USEPA Region II - Level IV Review

Site: RCRA Facility Investigation, CTO-108, Ceiba, PR SDG #: 680-23902-1

Client: CH2M Hill, Inc./Baker Environmental, Inc. Date: April 30, 2007

Laboratory: Severn Trent Laboratories, Savannah, GA Reviewer: Nancy Weaver

EDS ID	Client Sample ID	Laboratory Sample ID	Matrix
1	45B-SD04	680-23902-1	Soil
2	45B-SD04D	680-23902-2	Soil
3	45B-SD06	680-23902-3	Soil
4	45B-SD10	680-23902-4	Soil
5	45B-SD13	680-23902-5	Soil
6	45B-SD15	680-23902-6	Soil
7	45B-SD17	680-23902-7	Soil
8	REF-SD11	680-23902-8	Soil
8 MS	REF-SD11MS	680-23902-8MS	Soil
8MSD	REF-SD11MSD	680-23902-8MSD	Soil
9	REF-SD12	680-23902-9	Soil
10	45B-VEG-SED01	680-23902-10	Tissue
10 MS	45B-VEG-SED01MS	680-23902-10MS	Tissue
10 MSD	45B-VEG-SED01MSD	680-23902-10MSD	Tissue
11	45B-VEG-SED01D	680-23902-11	Tissue
12	45B-VEG-SED02	680-23902-12	Tissue
13	45B-VEG-SED03	680-23902-13	Tissue
14	REF2-VEG-SED01	680-23902-14	Tissue
15	REF2-VEG-SED02	680-23902-15	Tissue
16	REF2-VEG-SED03	680-23902-16	Tissue
17	45-ER01	680-23902-17EB	Water
18	45-FB01	680-23902-18FB	Water
19	45B-VEG-AB01	680-23902-19	Tissue
19 MS	45B-VEG-AB01MS	680-23902-19MS	Tissue
19 MSD	45B-VEG-AB01MSD	680-23902-19MSD	Tissue
20	45B-VEG-WB01	680-23902-20	Tissue
21	45B-VEG-AB02	680-23902-21	Tissue
22	45B-VEG-WB02	680-23902-22	Tissue
23	45B-VEG-AB03	680-23902-23	Tissue
24	45B-VEG-WB03	680-23902-24	Tissue

The USEPA Region II SOP No. HW-2, Revision 13, September 2005 for Evaluation of Metals Data for the Contract Laboratory Program was used in evaluating the data in this summary report.

Sample Conditions/Problems - The Traffic Reports/Chain-of-Custody Records, Sampling Report and/or Laboratory Case Narrative did not indicate any problems with sample receipt, condition of samples, analytical problems or special circumstances affecting the quality of the data.

Holding Times - All samples were prepared and analyzed within 28 days for mercury and 180 days for all other metals.

Calibration - The ICV and CCV %R values were acceptable.

CRDL Standard - The CRDL standards exhibited acceptable %R values except those noted below.

Compound	%R - High/Low	Qualifier	Affected Samples
Cadmium	111% - High	None	ND or already qualified (J)
Copper	145% - High	None	
Arsenic	116% - High	None	ND, already (J) or >2X CRDL
Selenium	115% - High	None	
Mercury	76.0% - Low	None	Already qualified (J) due to MS/MSD
Tin	68% - Low	UL	All Soil Samples

Method and Calibration Blanks - The method blanks and continuing calibration blanks exhibited the following contamination.

Soil

Compound	Conc.	Action Level	Qualifier	Affected Samples
Copper	0.083(PBS) mg/kg	0.415 mg/kg	None	All >5X

Water

Compound	Conc.	Action Level	Qualifier	Affected Samples
Copper	0.093 (ICB) ug/L	0.465 ug/L	None	All >5X

ICP Interference Check Sample - All %R values were acceptable.

Matrix Spike/Matrix Spike Duplicate - The matrix spike samples exhibited acceptable %R values except the following.

MS/MSD Sample ID	Compound	MS/MSD %R	Qualifier	Affected Samples
REF-SD11	Mercury	73.5/77.1	J/UJ	All REF-SED samples
	Tin	190%/189%	None	All ND

Field Duplicates - Field duplicate results are summarized below.

Compound	45B-SD04 mg/kg	45B-SD04D mg/kg	RPD	Qualifier
Arsenic	2.8	3.0	7	None
Cadmium	0.090 J	0.12 J	29	
Copper	18	25	33	
Mercury	0.0098 J	0.016 J	48	

Compound	45B-VEG-SED01 mg/kg	45B-VEG-SED01D mg/kg	RPD	Qualifier
Arsenic	3.9	4.5	14	None
Cadmium	0.057 J	0.075 J	27	
Selenium	0.19 J	0.18 J	5	
Mercury	0.0093 J	0.0089 J	4	

LCS - The LCS samples exhibited acceptable %R values.

ICP Serial Dilution - The ICP serial dilution samples exhibited acceptable %D values.

Field and Equipment Blank - Field QC results are summarized below.

Blank ID	Compound	Conc. ug/L	Action Level ug/L	Qualifier	Affected Samples
45-ER01	Copper	0.89	4.45	None	All >5X
45-FB01	Copper	0.40	2.00	None	

Compound Quantitation - No discrepancies were identified.

METALS
USEPA Region II - Level IV Review

Site: RCRA Facility Investigation, CTO-108, Ceiba, PR SDG #: 680-23974-1

Client: CH2M Hill, Inc./Baker Environmental, Inc. Date: April 18, 2007

Laboratory: Severn Trent Laboratories, Savannah, GA Reviewer: Nancy Weaver

EDS ID	Client Sample ID	Laboratory Sample ID	Matrix
1	REF2-VEG-WB03	680-23974-1	Tissue
2	REF2-VEG-AB03	680-23974-2	Tissue
3	REF2-VEG-WB02	680-23974-3	Tissue
4	REF2-VEG-AB02	680-23974-4	Tissue
5	REF2-VEG-WB01	680-23974-5	Tissue
6	REF2-VEG-AB01	680-23974-6	Tissue

The USEPA Region II SOP No. HW-2, Revision 13, September 2005 for Evaluation of Metals Data for the Contract Laboratory Program was used in evaluating the data in this summary report.

Sample Conditions/Problems - The Traffic Reports/Chain-of-Custody Records, Sampling Report and/or Laboratory Case Narrative did not indicate any problems with sample receipt, condition of samples, analytical problems or special circumstances affecting the quality of the data.

Holding Times - All samples were prepared and analyzed within 28 days for mercury and 180 days for all other metals.

Calibration - The ICV and CCV %R values were acceptable.

CRDL Standard - The CRDL standards exhibited acceptable %R values except those noted below. The associated samples were qualified as indicated.

Method and Calibration Blanks - The method blanks and continuing calibration blanks exhibited contamination for several compounds, however, all sample results are non-detect or greater than 5X the blank concentration.

ICP Interference Check Sample - All %R values were acceptable.

Matrix Spike/Matrix Spike Duplicate - The matrix spike samples exhibited acceptable %R values.

Field Duplicates - Field duplicate samples were not included in this data package.

LCS - The LCS samples exhibited acceptable %R values.

ICP Serial Dilution - The ICP serial dilution sample exhibited acceptable %D values.

Field and Equipment Blank - Field QC samples were not included in this data package.

Compound Quantitation - No discrepancies were identified.

SEVERN TRENT - SAVANNAH SDG 680-23974-1

DataQual

Environmental Services, LLC

Michael Baker, Jr., Inc.
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

October 29, 2008
SDG# SWMU23974, Test America-Savannah
NAPR SWMU 45, Step 6 Puerto Rico

Dear Mr. Kimes,

The following Data Validation report is provided as requested for the parameters noted in the table below for SDG # SWMU23974. The data validation was performed in accordance with the SW-846 methods utilized by the laboratory and professional judgment. The method in this SDG does not have an applicable Region II checklist SOP (SW-846 method 6020 for select metals (Cu, Pb & Zn). Therefore alternate worksheets were provided. Specific method requirements, Region II flagging conventions and professional judgment were used to validate the metals results. All areas of concern are discussed in the body of the report and a summary of data qualifications is provided.

Sample ID	Lab ID	Matrix	Metals
REF2-VEG-WB03	680-23974-1	tissue	X
REF2-VEG-AB03	680-23974-2	tissue	X
REF2-VEG-WB02	680-23974-3	tissue	X
REF2-VEG-AB02	680-23974-4	tissue	X
REF2-VEG-WB01	680-23974-5	tissue	X
REF2-VEG-AB01	680-23974-6	tissue	X

There were no quality control samples provided with this SDG.

The samples were evaluated based on the following criteria:

- Data Completeness *
- Technical Holding Times *
- Initial/Continuing Calibrations *
- CRDL Standards *
- ICSA/ICSAB Standards *
- Blanks
- Laboratory Control Samples *
- Matrix Spike Recoveries NA
- Matrix Duplicate RPDs NA
- Serial Dilutions *
- Field Duplicates NA
- Identification/Quantitation *
- Reporting Limits *

* - indicates that qualifications were not required based on this criteria

Overall Evaluation of Data/Potential Usability Issues

A summary of qualifications applied to the sample results are noted below for the fractions validated. Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. If an issue is not addressed there were no actions required based on unmet quality criteria. When more than one qualifier is associated with a compound/analyte the validator has chosen the qualifier that best indicates possible bias in the results and flagged the data accordingly. However, information regarding all quality control issues is provided in the body of the report and on the qualification summary page.

Metals

Blank contamination was noted and qualification was required in the samples in this SDG.

Specific Evaluation of Data

Data Completeness

The SDG was received complete and intact. Resubmissions were not required.

Technical Holding Times

According to chain of custody records, sampling was performed on 1/31/07 and samples were received at the laboratory 2/2/07. Sample preparation and analysis was performed within Region II and/or method holding time requirements.

Blanks

Metals

Associated blanks exhibited contamination as noted in the following table. The laboratory reported non-detect results to the RL for this project.

Blank ID	Analyte	Concentration	Action Level	Q Flag
PBlk	copper	0.1965J mg/Kg	RL	U at RL
	zinc	1.2990J mg/Kg	RL	U at RL

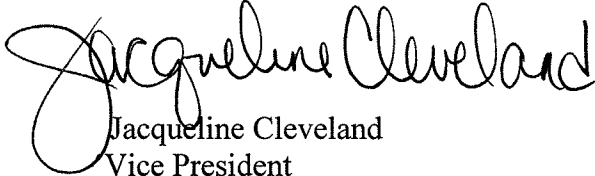
Associated samples and required qualifications are noted in the following table.

Sample ID	Analyte	Q Flag
all samples >MDL but less than RL	copper	U at RL
all samples >MDL but less than RL	zinc	U at RL

Michael Baker, Jr., Inc.
NAPR SWMU45, Puerto Rico
SDG# SWMU23974
Page 2

A summary of qualifications required is provided on the following page. Please do not hesitate to contact DataQual ES with any questions regarding this validation report.

Sincerely,



Handwritten signature of Jacqueline Cleveland in cursive script.

Jacqueline Cleveland
Vice President

Summary of Data Qualifications

Metals

Sample ID	Analyte	Results	Q flag
all samples	copper	+J (all >MDL but less than RL)	U at RL
all samples	zinc		

Glossary of Qualification Flags and Abbreviations

Qualification Flags (Q-Flags)

U	not detected above the reported sample quantitation limit
J	estimated value
UJ	reported quantitation limit is qualified as estimated
-	analyte has been tentatively identified
JN	analyte has been tentatively identified, estimated value
R	result is rejected; the presence or absence of the analyte cannot be verified

Method/Preparation Blank Qualification Flags (Q-Flags)

Organic Methods

NA	The sample result for the blank contaminant is greater than the sample RL and is greater than 5X (10X for common laboratory contaminants) the blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.
U	The sample result for the blank contaminant is greater than the sample RL and is less than 5X (10X for common laboratory contaminants) the blank value.
CRQL	The sample result for the blank contaminant is less than the sample RL and is less than 5X (10X for common laboratory contaminants) the blank value.

Inorganic Methods

ICB/CCB/PB Action:

No Action -	The sample result is greater than the RL and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the RL, result is reported as non-detect at the reporting limit, when the ICB/CCB/PB result is less than the RL.
R -	Sample result is greater than the RL and less than the ICB/CCB value when the ICB/CCB/PB value is greater than the RL.

Glossary of Qualification Flags and Abbreviations

Field QC Blank action:

Note – Use field blanks to qualify data only if field blank results are greater than prep blank results.

Do not use rinsate blank associated with soils to qualify water samples and vice versa.

- No Action - The sample result is greater than the RL and greater than ten times (10X) the blank value.
- U - The sample result is greater than or equal to the MDL but less than or equal to the RL when the field blank result is greater than the RL - result is reported as non-detect at the reporting limit.
- R - Sample result is greater than the RL and less than the field blank value when the field blank result is greater than the RL.
- J - Sample result is greater than the field blank value but less than 10X the field blank value when field blank result is greater than the RL.

General Abbreviations

RL	reporting limit
IDL	instrument detection limit
MDL	method detection limit
CRDL	contract required detection limit
CRQL	contract required quantitation limit
+	positive result
-	non-detect result

APPENDIX G
95 PERCENT UCL OF THE MEAN ECOLOGICAL COC
CONCENTRATIONS IN SWMU 2 SOIL

Antimony**SWMU 2 Soil: Combined Surface and Subsurface Soil Data Set**

General Statistics

Number of Valid Data	94	Number of Detected Data	80
Number of Distinct Detected Data	66	Number of Non-Detect Data	14
		Percent Non-Detects	14.89%

Raw Statistics

Minimum Detected	0.036
Maximum Detected	36
Mean of Detected	2.914
SD of Detected	6.033
Minimum Non-Detect	0.15
Maximum Non-Detect	4

Log-transformed Statistics

Minimum Detected	-3.324
Maximum Detected	3.584
Mean of Detected	-0.341
SD of Detected	1.753
Minimum Non-Detect	-1.897
Maximum Non-Detect	1.386

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	81
Number treated as Detected	13
Single DL Non-Detect Percentage	86.17%

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.317
5% Lilliefors Critical Value	0.0991

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0631
5% Lilliefors Critical Value	0.0991

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	2.585
SD	5.621
95% DL/2 (t) UCL	3.548

Maximum Likelihood Estimate (MLE) Method N/A
MLE yields a negative mean

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-0.414
SD	1.683
95% H-Stat (DL/2) UCL	4.546

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.448
Theta Star	6.506
nu star	71.67

A-D Test Statistic	2.68
5% A-D Critical Value	0.829
K-S Test Statistic	0.829
5% K-S Critical Value	0.106

Data not Gamma Distributed at 5% Significance Level

Log ROS Method	
Mean in Log Scale	-0.535
SD in Log Scale	1.706
Mean in Original Scale	2.517
SD in Original Scale	5.642
95% Percentile Bootstrap UCL	3.562
95% BCA Bootstrap UCL	3.754

Data Distribution Test with Detected Values Only
Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	2.532
SD	5.609
SE of Mean	0.582
95% KM (t) UCL	3.5
95% KM (z) UCL	3.49
95% KM (jackknife) UCL	3.499
95% KM (bootstrap t) UCL	3.898
95% KM (BCA) UCL	3.542
95% KM (Percentile Bootstrap) UCL	3.517
95% KM (Chebyshev) UCL	5.071
97.5% KM (Chebyshev) UCL	6.169
99% KM (Chebyshev) UCL	8.327

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	1E-09
Maximum	36
Mean	2.591
Median	0.785
SD	5.626
k star	0.24
Theta star	10.8
Nu star	45.09
AppChi2	30.69
95% Gamma Approximate UCL	3.808
95% Adjusted Gamma UCL	3.831

Note: DL/2 is not a recommended method.

Potential UCLs to use:

97.5% KM (Chebyshev) UCL 6.169 mg/kg

Copper**SWMU 2 Soil: Combined Surface and Subsurface Soil Data Set**

General Statistics

Number of Valid Data	94	Number of Detected Data	93
Number of Distinct Detected Data	77	Number of Non-Detect Data	1
		Percent Non-Detects	1.06%

Raw Statistics

Minimum Detected	16.9
Maximum Detected	19300
Mean of Detected	553.8
SD of Detected	2231
Minimum Non-Detect	4.3
Maximum Non-Detect	4.3

Log-transformed Statistics

Minimum Detected	2.827
Maximum Detected	9.868
Mean of Detected	5.074
SD of Detected	1.1
Minimum Non-Detect	1.459
Maximum Non-Detect	1.459

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.418
5% Lilliefors Critical Value	0.0919

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.142
5% Lilliefors Critical Value	0.0919

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	547.9
SD	2220
95% DL/2 (t) UCL	928.3

Maximum Likelihood Estimate (MLE) Method

Mean	531
SD	2222
95% MLE (t) UCL	911.8
95% MLE (Tiku) UCL	865.2

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	5.028
SD	1.18
95% H-Stat (DL/2) UCL	403.5

Log ROS Method

Mean in Log Scale	5.044
SD in Log Scale	1.131
Mean in Original Scale	548
SD in Original Scale	2220
95% Percentile Bootstrap UCL	956.1
95% BCA Bootstrap UCL	1205

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.5
Theta Star	1107
nu star	93.05

A-D Test Statistic	13.52
5% A-D Critical Value	0.818
K-S Test Statistic	0.818
5% K-S Critical Value	0.0981

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	548.1
SD	2208
SE of Mean	229
95% KM (t) UCL	928.5
95% KM (z) UCL	924.7
95% KM (jackknife) UCL	928.3
95% KM (bootstrap t) UCL	1676
95% KM (BCA) UCL	968.1
95% KM (Percentile Bootstrap) UCL	948.7
95% KM (Chebyshev) UCL	1546
97.5% KM (Chebyshev) UCL	1978
99% KM (Chebyshev) UCL	2826

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	1E-09
Maximum	19300
Mean	547.9
Median	130
SD	2220
k star	0.425
Theta star	1290
Nu star	79.86
AppChi2	60.27
95% Gamma Approximate UCL	726
95% Adjusted Gamma UCL	729.2

Potential UCLs to use:**95% KM (Chebyshev) UCL 1546 mg/kg**

Note: DL/2 is not a recommended method.

Lead**SWMU 2 Soil: Combined Surface and Subsurface Soil Data Set**

General Statistics

Number of Valid Observations 94

Number of Distinct Observations 85

Raw Statistics

Minimum 3.1
Maximum 5850
Mean 354.5
Median 110
SD 863.8
Coefficient of Variation 2.437
Skewness 4.879

Log-transformed Statistics

Minimum of Log Data 1.131
Maximum of Log Data 8.674
Mean of log Data 4.705
SD of log Data 1.483

Lognormal Distribution Test

Lilliefors Test Statistic 0.07
Lilliefors Critical Value 0.0914

Data appear Lognormal at 5% Significance Level

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic 0.342
Lilliefors Critical Value 0.0914

Data not Normal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL 503.4
95% Chebyshev (MVUE) UCL 621.3
97.5% Chebyshev (MVUE) UCL 750
99% Chebyshev (MVUE) UCL 1003

Assuming Normal Distribution

95% Student's-t UCL 502.5
95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL 549
95% Modified-t UCL 510

Data Distribution

Data appear Lognormal at 5% Significance Level

Gamma Distribution Test

k star (bias corrected) 0.528
Theta Star 670.8
nu star 99.35
Approximate Chi Square Value (.05) 77.36
Adjusted Level of Significance 0.0474
Adjusted Chi Square Value 77.06

Anderson-Darling Test Statistic 4.211
Anderson-Darling 5% Critical Value 0.815
Kolmogorov-Smirnov Test Statistic 0.185
Kolmogorov-Smirnov 5% Critical Value 0.0974

Data not Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 501.1
95% Jackknife UCL 502.5
95% Standard Bootstrap UCL 500.2
95% Bootstrap-t UCL 659.4
95% Hall's Bootstrap UCL 673.1
95% Percentile Bootstrap UCL 508.3
95% BCA Bootstrap UCL 564.5
95% Chebyshev(Mean, Sd) UCL 742.9
97.5% Chebyshev(Mean, Sd) UCL 910.9
99% Chebyshev(Mean, Sd) UCL 1241

Potential UCL to use:**Use 95% H-UCL****503.4 mg/kg**

Assuming Gamma Distribution

95% Approximate Gamma UCL 455.3
95% Adjusted Gamma UCL 457.1

Mercury**SWMU 2 Soil: Combined Surface and Subsurface Soil Data Set**

General Statistics

Number of Valid Data	94	Number of Detected Data	88
Number of Distinct Detected Data	58	Number of Non-Detect Data	6
		Percent Non-Detects	6.38%

Raw Statistics

Minimum Detected	0.026
Maximum Detected	19
Mean of Detected	0.573
SD of Detected	2.23
Minimum Non-Detect	0.12
Maximum Non-Detect	0.16

Log-transformed Statistics

Minimum Detected	-3.65
Maximum Detected	2.944
Mean of Detected	-1.738
SD of Detected	1.128
Minimum Non-Detect	-2.12
Maximum Non-Detect	-1.833

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	50
Number treated as Detected	44
Single DL Non-Detect Percentage	53.19%

UCL Statistics

Test with Detected Values Only

Lilliefors Test Statistic	0.417
5% Lilliefors Critical Value	0.0944

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Lilliefors Test Statistic	0.0803
5% Lilliefors Critical Value	0.0944

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.541
SD	2.16
95% DL/2 (t) UCL	0.911

Maximum Likelihood Estimate (MLE) Method N/A
MLE yields a negative mean

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.522
Theta Star	1.099
nu star	91.83

A-D Test Statistic	10.34
5% A-D Critical Value	0.815
K-S Test Statistic	0.815
5% K-S Critical Value	0.101

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	1E-09
Maximum	19
Mean	0.537
Median	0.145
SD	2.162
k star	0.294
Theta star	1.823
Nu star	55.35
AppChi2	39.25
95% Gamma Approximate UCL	0.757
95% Adjusted Gamma UCL	0.761

Note: DL/2 is not a recommended method.

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-1.798
SD	1.116
95% H-Stat (DL/2) UCL	0.437

Log ROS Method	
Mean in Log Scale	-1.796
SD in Log Scale	1.115
Mean in Original Scale	0.541
SD in Original Scale	2.16
95% Percentile Bootstrap UCL	0.923
95% BCA Bootstrap UCL	1.155

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.542
SD	2.149
SE of Mean	0.223
95% KM (t) UCL	0.912
95% KM (z) UCL	0.908
95% KM (jackknife) UCL	0.912
95% KM (bootstrap t) UCL	2.085
95% KM (BCA) UCL	0.983
95% KM (Percentile Bootstrap) UCL	0.964
95% KM (Chebyshev) UCL	1.513
97.5% KM (Chebyshev) UCL	1.934
99% KM (Chebyshev) UCL	2.759

Potential UCLs to use:

95% KM (Chebyshev) UCL 1.513 mg/kg

Zinc**SWMU 2 Soil: Combined Surface and Subsurface Soil Data Set**

General Statistics

Number of Valid Observations 94

Number of Distinct Observations 87

Raw Statistics

Minimum 8.3
Maximum 12700
Mean 602.2
Median 174
SD 1497
Coefficient of Variation 2.485
Skewness 6.295

Log-transformed Statistics

Minimum of Log Data 2.116
Maximum of Log Data 9.449
Mean of log Data 5.399
SD of log Data 1.283

Lognormal Distribution Test

Lilliefors Test Statistic 0.112
Lilliefors Critical Value 0.0914

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic 0.346
Lilliefors Critical Value 0.0914

Data not Normal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 858.7
95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL 963.2
95% Modified-t UCL 875.4

Assuming Lognormal Distribution

95% H-UCL 702
95% Chebyshev (MVUE) UCL 867.9
97.5% Chebyshev (MVUE) UCL 1029
99% Chebyshev (MVUE) UCL 1345

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Gamma Distribution Test

k star (bias corrected) 0.602
Theta Star 999.7
nu star 113.2
Approximate Chi Square Value (.05) 89.68
Adjusted Level of Significance 0.0474
Adjusted Chi Square Value 89.36

Anderson-Darling Test Statistic 5.538
Anderson-Darling 5% Critical Value 0.807
Kolmogorov-Smirnov Test Statistic 0.205
Kolmogorov-Smirnov 5% Critical Value 0.0968

Data not Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 856.1
95% Jackknife UCL 858.7
95% Standard Bootstrap UCL 851.7
95% Bootstrap-t UCL 1156
95% Hall's Bootstrap UCL 1847
95% Percentile Bootstrap UCL 877.4
95% BCA Bootstrap UCL 994.8
95% Chebyshev(Mean, Sd) UCL 1275
97.5% Chebyshev(Mean, Sd) UCL 1566
99% Chebyshev(Mean, Sd) UCL 2138

Potential UCL to use:**97.5% Chebyshev (Mean, Sd) UCL 1566 mg/kg**

Assuming Gamma Distribution

95% Approximate Gamma UCL 760.5
95% Adjusted Gamma UCL 763.2

APPENDIX H
REGRESSION REPORTS FOR EISENIA FETIDA SURVIVAL AND
GROWTH DATA

PAIR-WISE LINEAR REGRESSION REPORTS

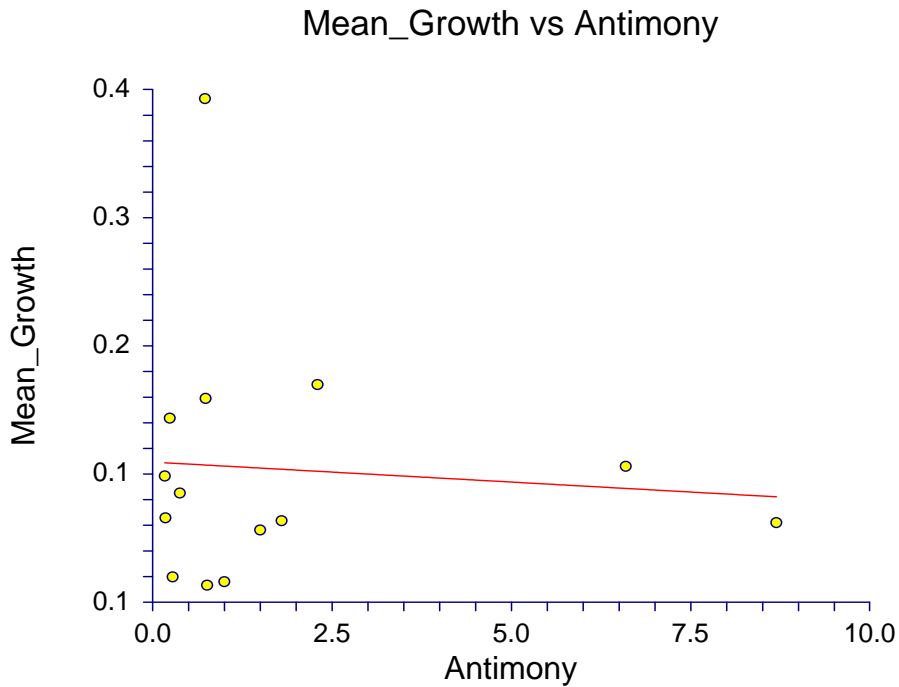
Linear Regression Report

Page/Date/Time 1 8/17/2009 11:48:35 AM

Database

Y = Mean_Growth X = Antimony

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Antimony	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1320	Rows Prediction Only	1
Slope	-0.0023	Sum of Frequencies	14
R-Squared	0.0069	Sum of Weights	14.0000
Correlation	-0.0828	Coefficient of Variation	0.5922
Mean Square Error	5.722459E-03	Square Root of MSE	7.564694E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:48:35 AM
Y = Mean_Growth X = Antimony

Summary Statement

The equation of the straight line relating Mean_Growth and Antimony is estimated as:
 $\text{Mean_Growth} = (0.1320) + (-0.0023) \text{ Antimony}$ using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Antimony is zero, is 0.1320 with a standard error of 0.0250. The slope, the estimated change in Mean_Growth per unit change in Antimony, is -0.0023 with a standard error of 0.0081. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Antimony, is 0.0069. The correlation between Mean_Growth and Antimony is -0.0828.

A significance test that the slope is zero resulted in a t-value of -0.2879. The significance level of this t-test is 0.7784. Since $0.7784 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0023. The lower limit of the 95% confidence interval for the slope is -0.0200 and the upper limit is 0.0153. The estimated intercept is 0.1320. The lower limit of the 95% confidence interval for the intercept is 0.0775 and the upper limit is 0.1864.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Antimony
Count	14	14
Mean	0.1277	1.8129
Standard Deviation	0.0729	2.5872
Minimum	0.0599	0.1700
Maximum	0.3446	8.7000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:48:35 AM

Database

Y = Mean_Growth X = Antimony

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1320	-0.0023
Lower 95% Confidence Limit	0.0775	-0.0200
Upper 95% Confidence Limit	0.1864	0.0153
Standard Error	0.0250	0.0081
Standardized Coefficient	0.0000	-0.0828
T Value	5.2790	-0.2879
Prob Level (T Test)	0.0002	0.7784
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9979	0.0581
Regression of Y on X	0.1320	-0.0023
Inverse Regression from X on Y	0.7448	-0.3404
Orthogonal Regression of Y and X	0.1320	-0.0023

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(.131960314635605) + (-2.33429491325752E-03) * (\text{Antimony})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2284042	0.2284042			
Slope	1	4.741633E-04	4.741633E-04	0.0829	0.7784	0.0581
Error	12	6.866951E-02	5.722459E-03			
Adj. Total	13	6.914367E-02	5.318744E-03			
Total	14	0.2975479				

$s = \text{Square Root}(5.722459E-03) = 7.564694E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:48:35 AM

Database

Y = Mean_Growth X = Antimony

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7918	0.003954	No
Anderson Darling	0.9184	0.019573	No
D'Agostino Skewness	3.1372	0.001706	No
D'Agostino Kurtosis	2.8512	0.004356	No
D'Agostino Omnibus	17.9713	0.000125	No
Constant Residual Variance?			
Modified Levene Test	0.6560	0.433734	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

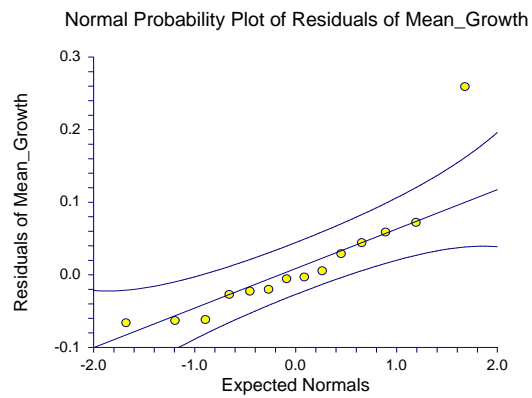
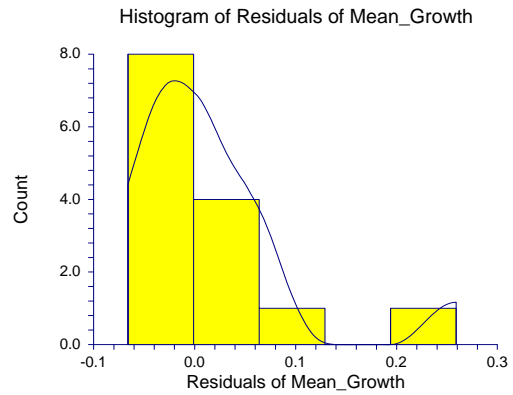
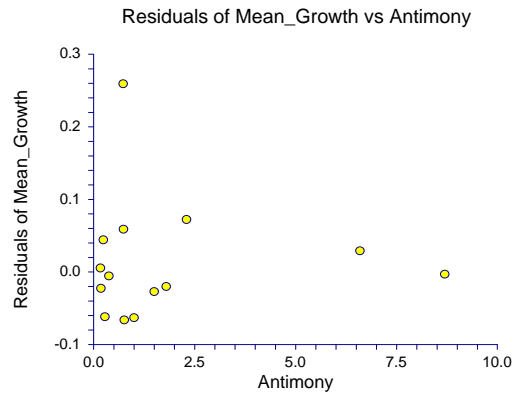
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:48:35 AM

Database

Y = Mean_Growth X = Antimony

Residual Plots Section



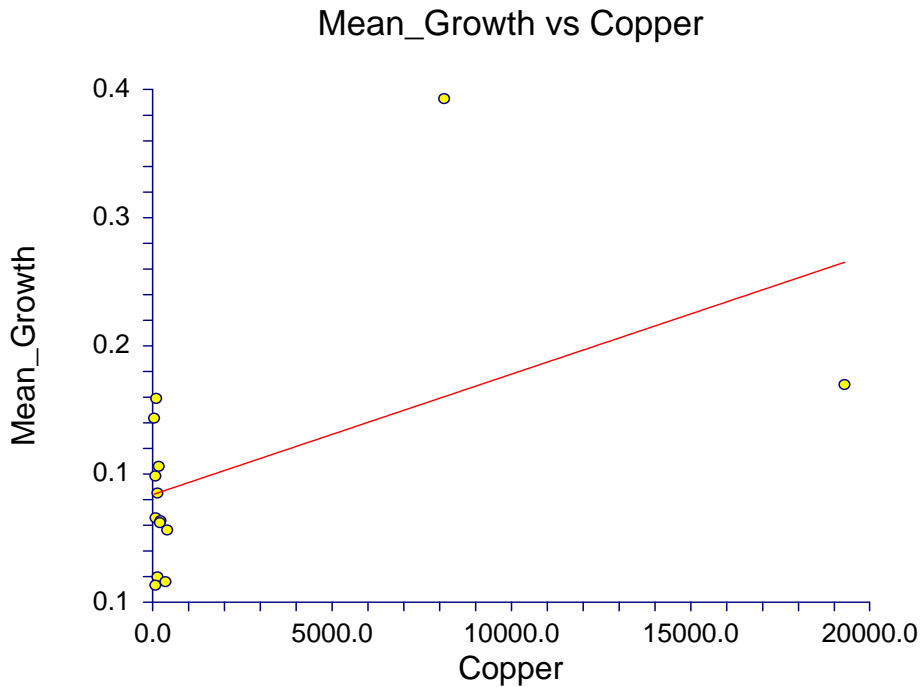
Linear Regression Report

Page/Date/Time 1 8/17/2009 11:48:53 AM

Database

Y = Mean_Growth X = Copper

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Copper	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1129	Rows Prediction Only	1
Slope	0.0000	Sum of Frequencies	14
R-Squared	0.2706	Sum of Weights	14.0000
Correlation	0.5202	Coefficient of Variation	0.5075
Mean Square Error	4.202712E-03	Square Root of MSE	6.482833E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:48:53 AM
Y = Mean_Growth X = Copper

Summary Statement

The equation of the straight line relating Mean_Growth and Copper is estimated as: $\text{Mean_Growth} = (0.1129) + (0.0000) \text{Copper}$ using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Copper is zero, is 0.1129 with a standard error of 0.0187. The slope, the estimated change in Mean_Growth per unit change in Copper, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Copper, is 0.2706. The correlation between Mean_Growth and Copper is 0.5202.

A significance test that the slope is zero resulted in a t-value of 2.1100. The significance level of this t-test is 0.0565. Since $0.0565 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1129. The lower limit of the 95% confidence interval for the intercept is 0.0722 and the upper limit is 0.1537.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Copper
Count	14	14
Mean	0.1277	2102.0786
Standard Deviation	0.0729	5386.6126
Minimum	0.0599	41.0000
Maximum	0.3446	19300.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:48:53 AM

Database

Y = Mean_Growth X = Copper

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1129	0.0000
Lower 95% Confidence Limit	0.0722	0.0000
Upper 95% Confidence Limit	0.1537	0.0000
Standard Error	0.0187	0.0000
Standardized Coefficient	0.0000	0.5202
T Value	6.0410	2.1100
Prob Level (T Test)	0.0001	0.0565
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9998	0.4922
Regression of Y on X	0.1129	0.0000
Inverse Regression from X on Y	0.0730	0.0000
Orthogonal Regression of Y and X	0.1129	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.112923469427487) + (7.04307736271856E-06) * (Copper)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2284042	0.2284042			
Slope	1	1.871112E-02	1.871112E-02	4.4522	0.0565	0.4922
Error	12	5.043255E-02	4.202712E-03			
Adj. Total	13	6.914367E-02	5.318744E-03			
Total	14	0.2975479				

$s = \text{Square Root}(4.202712\text{E-}03) = 6.482833\text{E-}02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:48:53 AM

Database

Y = Mean_Growth X = Copper

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8462	0.019733	No
Anderson Darling	0.7134	0.062673	No
D'Agostino Skewness	2.7401	0.006142	No
D'Agostino Kurtosis	2.4242	0.015341	No
D'Agostino Omnibus	13.3849	0.001240	No
Constant Residual Variance?			
Modified Levene Test	0.2489	0.626881	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

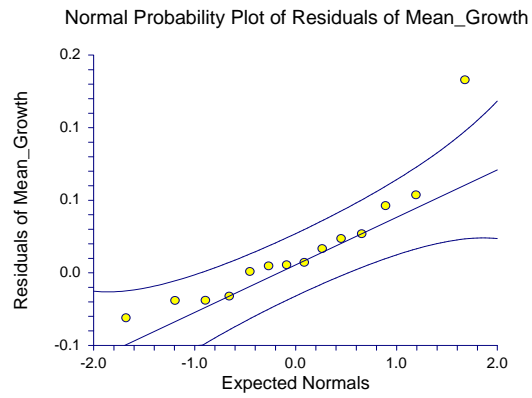
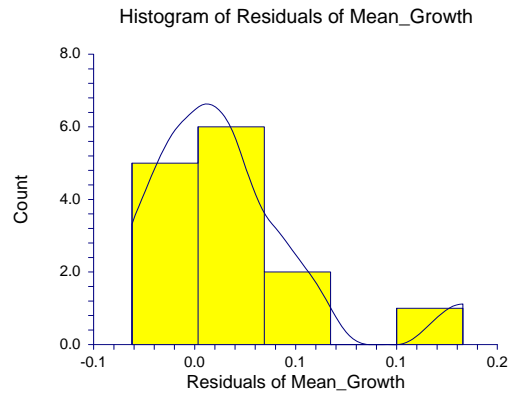
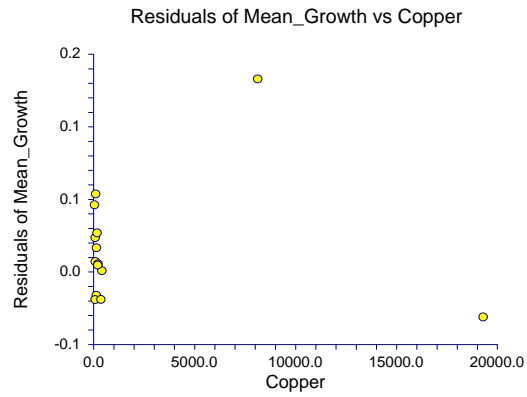
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:48:53 AM

Database

Y = Mean_Growth X = Copper

Residual Plots Section



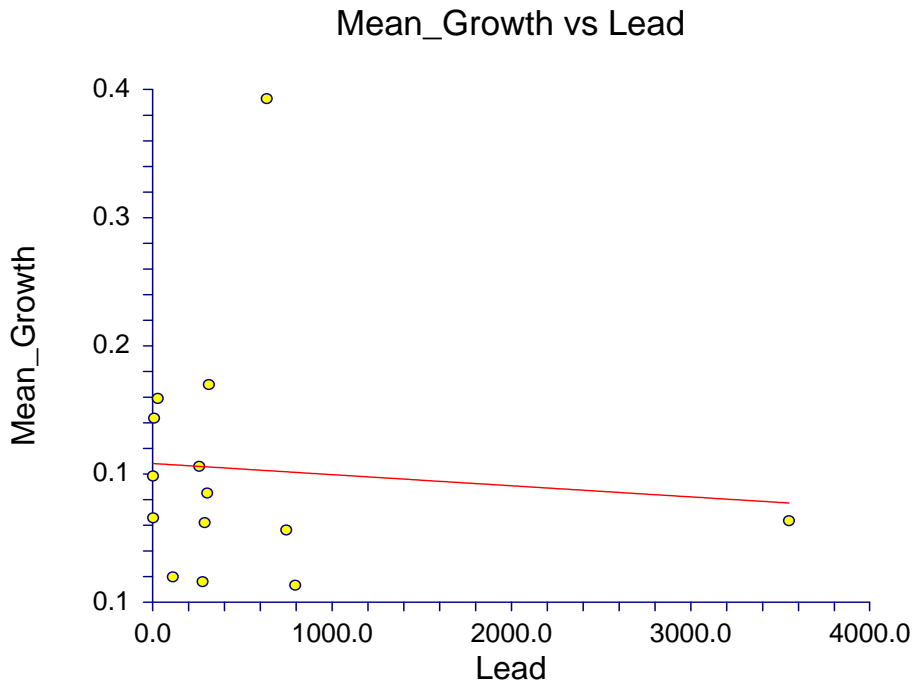
Linear Regression Report

Page/Date/Time 1 8/17/2009 11:49:09 AM

Database

Y = Mean_Growth X = Lead

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Lead	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1311	Rows Prediction Only	1
Slope	0.0000	Sum of Frequencies	14
R-Squared	0.0066	Sum of Weights	14.0000
Correlation	-0.0813	Coefficient of Variation	0.5923
Mean Square Error	5.723857E-03	Square Root of MSE	7.565618E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:49:09 AM
Y = Mean_Growth X = Lead

Summary Statement

The equation of the straight line relating Mean_Growth and Lead is estimated as: $\text{Mean_Growth} = (0.1311) + (0.0000) \text{Lead}$ using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Lead is zero, is 0.1311 with a standard error of 0.0235. The slope, the estimated change in Mean_Growth per unit change in Lead, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Lead, is 0.0066. The correlation between Mean_Growth and Lead is -0.0813.

A significance test that the slope is zero resulted in a t-value of -0.2827. The significance level of this t-test is 0.7822. Since $0.7822 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is -0.0001 and the upper limit is 0.0000. The estimated intercept is 0.1311. The lower limit of the 95% confidence interval for the intercept is 0.0798 and the upper limit is 0.1824.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Lead
Count	14	14
Mean	0.1277	523.6571
Standard Deviation	0.0729	911.1542
Minimum	0.0599	2.1000
Maximum	0.3446	3550.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:49:09 AM

Database

Y = Mean_Growth X = Lead

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1311	0.0000
Lower 95% Confidence Limit	0.0798	-0.0001
Upper 95% Confidence Limit	0.1824	0.0000
Standard Error	0.0235	0.0000
Standardized Coefficient	0.0000	-0.0813
T Value	5.5701	-0.2827
Prob Level (T Test)	0.0001	0.7822
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9991	0.0578
Regression of Y on X	0.1311	0.0000
Inverse Regression from X on Y	0.6431	-0.0010
Orthogonal Regression of Y and X	0.1311	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.131137529407781) + (-6.5099044779761E-06) * (Lead)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2284042	0.2284042			
Slope	1	4.573791E-04	4.573791E-04	0.0799	0.7822	0.0578
Error	12	6.868629E-02	5.723857E-03			
Adj. Total	13	6.914367E-02	5.318744E-03			
Total	14	0.2975479				

$s = \text{Square Root}(5.723857E-03) = 7.565618E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:49:09 AM

Database

Y = Mean_Growth X = Lead

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7698	0.002161	No
Anderson Darling	1.0362	0.010032	No
D'Agostino Skewness	3.2694	0.001078	No
D'Agostino Kurtosis	2.9749	0.002931	No
D'Agostino Omnibus	19.5390	0.000057	No
Constant Residual Variance?			
Modified Levene Test	0.4987	0.493573	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

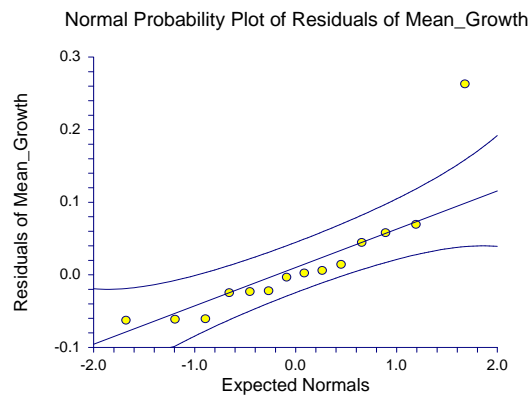
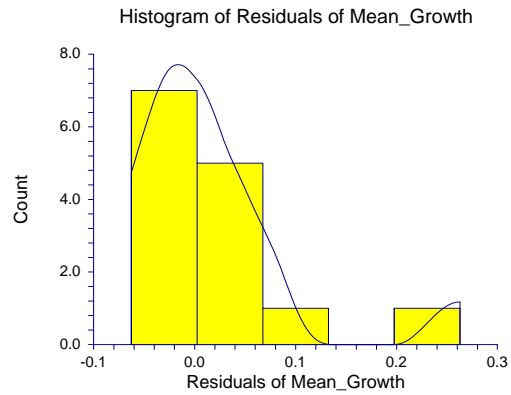
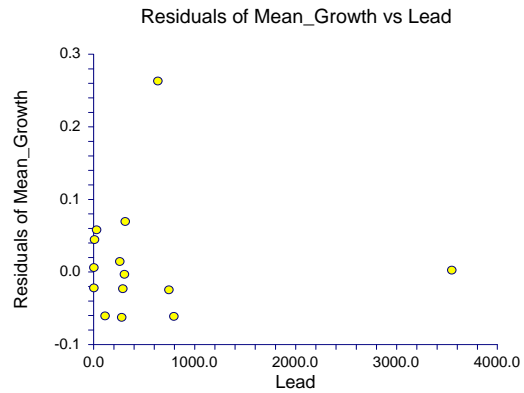
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:49:09 AM

Database

Y = Mean_Growth X = Lead

Residual Plots Section



Linear Regression Report

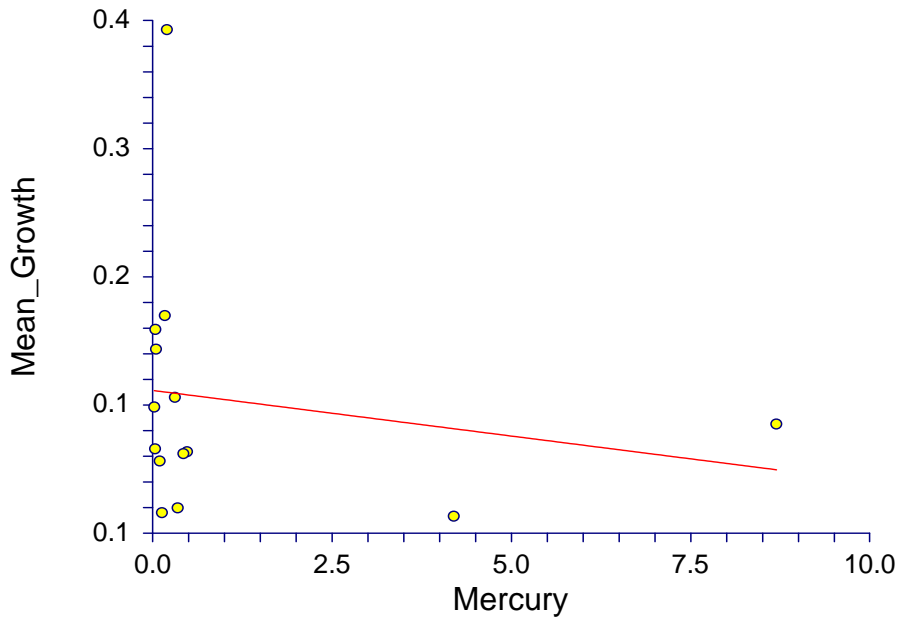
Page/Date/Time 1 8/17/2009 11:49:30 AM

Database

Y = Mean_Growth X = Mercury

Linear Regression Plot Section

Mean_Growth vs Mercury



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Mercury	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1335	Rows Prediction Only	1
Slope	-0.0053	Sum of Frequencies	14
R-Squared	0.0319	Sum of Weights	14.0000
Correlation	-0.1787	Coefficient of Variation	0.5847
Mean Square Error	5.578034E-03	Square Root of MSE	7.468624E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:49:30 AM
Y = Mean_Growth X = Mercury

Summary Statement

The equation of the straight line relating Mean_Growth and Mercury is estimated as: $\text{Mean_Growth} = (0.1335) + (-0.0053) \text{ Mercury}$ using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Mercury is zero, is 0.1335 with a standard error of 0.0220. The slope, the estimated change in Mean_Growth per unit change in Mercury, is -0.0053 with a standard error of 0.0085. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Mercury, is 0.0319. The correlation between Mean_Growth and Mercury is -0.1787.

A significance test that the slope is zero resulted in a t-value of -0.6291. The significance level of this t-test is 0.5411. Since $0.5411 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0053. The lower limit of the 95% confidence interval for the slope is -0.0238 and the upper limit is 0.0131. The estimated intercept is 0.1335. The lower limit of the 95% confidence interval for the intercept is 0.0856 and the upper limit is 0.1814.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Mercury
Count	14	14
Mean	0.1277	1.0866
Standard Deviation	0.0729	2.4422
Minimum	0.0599	0.0240
Maximum	0.3446	8.7000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:49:30 AM

Database

Y = Mean_Growth X = Mercury

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1335	-0.0053
Lower 95% Confidence Limit	0.0856	-0.0238
Upper 95% Confidence Limit	0.1814	0.0131
Standard Error	0.0220	0.0085
Standardized Coefficient	0.0000	-0.1787
T Value	6.0733	-0.6291
Prob Level (T Test)	0.0001	0.5411
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9998	0.0894
Regression of Y on X	0.1335	-0.0053
Inverse Regression from X on Y	0.3093	-0.1671
Orthogonal Regression of Y and X	0.1335	-0.0053

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.133526440210682) + (-5.33557897518842E-03) * (Mercury)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2284042	0.2284042			
Slope	1	2.207266E-03	2.207266E-03	0.3957	0.5411	0.0894
Error	12	0.0669364	5.578034E-03			
Adj. Total	13	6.914367E-02	5.318744E-03			
Total	14	0.2975479				

$s = \text{Square Root}(5.578034E-03) = 7.468624E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:49:30 AM

Database

Y = Mean_Growth X = Mercury

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7860	0.003363	No
Anderson Darling	0.9595	0.015496	No
D'Agostino Skewness	3.1615	0.001569	No
D'Agostino Kurtosis	2.8632	0.004193	No
D'Agostino Omnibus	18.1934	0.000112	No
Constant Residual Variance?			
Modified Levene Test	0.3502	0.565007	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

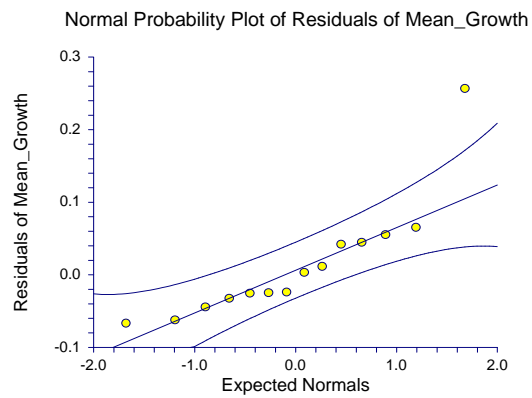
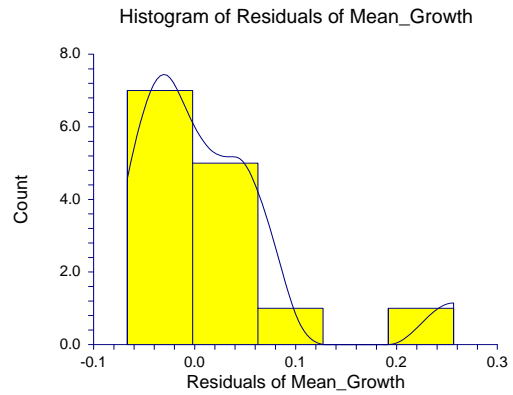
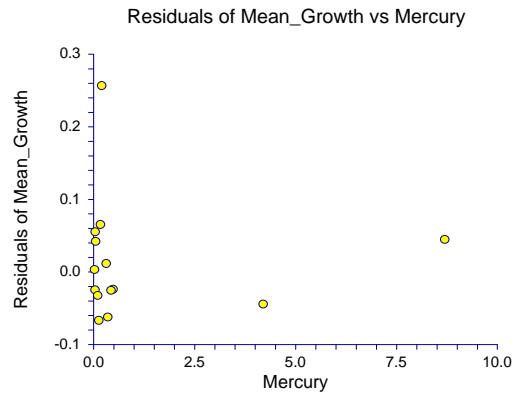
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:49:30 AM

Database

Y = Mean_Growth X = Mercury

Residual Plots Section



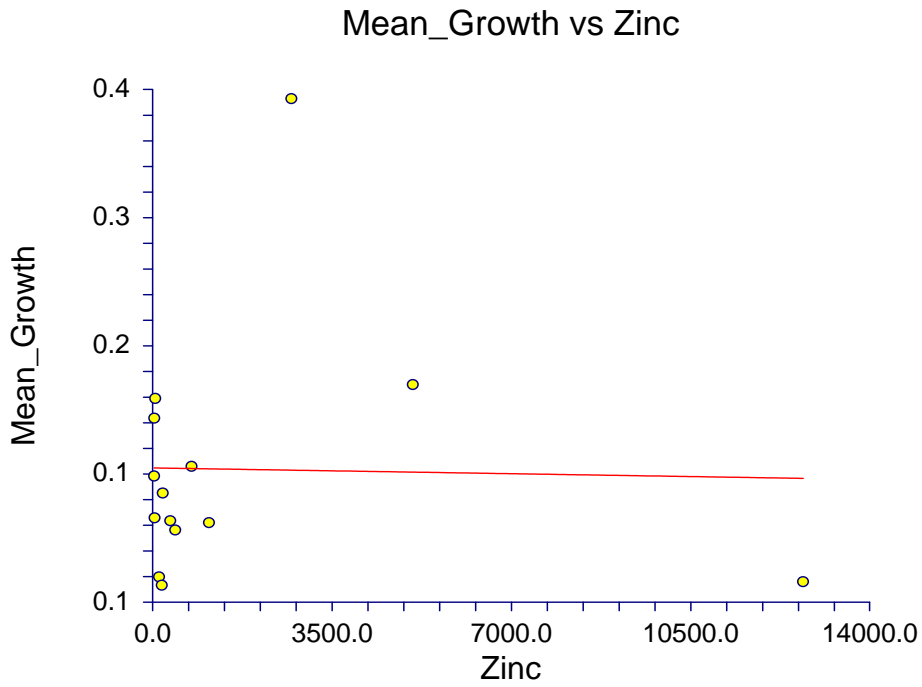
Linear Regression Report

Page/Date/Time 1 8/17/2009 11:49:46 AM

Database

Y = Mean_Growth X = Zinc

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Zinc	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1285	Rows Prediction Only	1
Slope	0.0000	Sum of Frequencies	14
R-Squared	0.0005	Sum of Weights	14.0000
Correlation	-0.0228	Coefficient of Variation	0.5941
Mean Square Error	5.758964E-03	Square Root of MSE	7.588784E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:49:46 AM
Y = Mean_Growth X = Zinc

Summary Statement

The equation of the straight line relating Mean_Growth and Zinc is estimated as: $\text{Mean_Growth} = (0.1285) + (0.0000) \text{Zinc}$ using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Zinc is zero, is 0.1285 with a standard error of 0.0228. The slope, the estimated change in Mean_Growth per unit change in Zinc, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Zinc, is 0.0005. The correlation between Mean_Growth and Zinc is -0.0228.

A significance test that the slope is zero resulted in a t-value of -0.0792. The significance level of this t-test is 0.9382. Since $0.9382 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1285. The lower limit of the 95% confidence interval for the intercept is 0.0790 and the upper limit is 0.1781.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Zinc
Count	14	14
Mean	0.1277	1698.7857
Standard Deviation	0.0729	3466.6645
Minimum	0.0599	30.0000
Maximum	0.3446	12700.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:49:46 AM

Database

Y = Mean_Growth X = Zinc

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1285	0.0000
Lower 95% Confidence Limit	0.0790	0.0000
Upper 95% Confidence Limit	0.1781	0.0000
Standard Error	0.0228	0.0000
Standardized Coefficient	0.0000	-0.0228
T Value	5.6494	-0.0792
Prob Level (T Test)	0.0001	0.9382
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9993	0.0506
Regression of Y on X	0.1285	0.0000
Inverse Regression from X on Y	1.6918	-0.0009
Orthogonal Regression of Y and X	0.1285	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.128545150697548) + (-4.80684092236757E-07) * (Zinc)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2284042	0.2284042			
Slope	1	3.609828E-05	3.609828E-05	0.0063	0.9382	0.0506
Error	12	6.910757E-02	5.758964E-03			
Adj. Total	13	6.914367E-02	5.318744E-03			
Total	14	0.2975479				

$s = \text{Square Root}(5.758964E-03) = 7.588784E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:49:46 AM

Database

Y = Mean_Growth X = Zinc

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7732	0.002372	No
Anderson Darling	1.0353	0.010084	No
D'Agostino Skewness	3.2610	0.001110	No
D'Agostino Kurtosis	2.9340	0.003346	No
D'Agostino Omnibus	19.2428	0.000066	No
Constant Residual Variance?			
Modified Levene Test	0.4961	0.494681	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

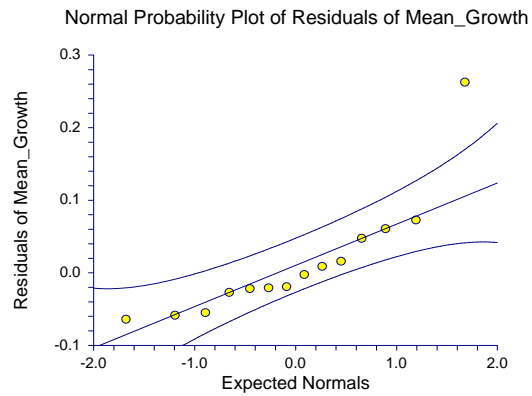
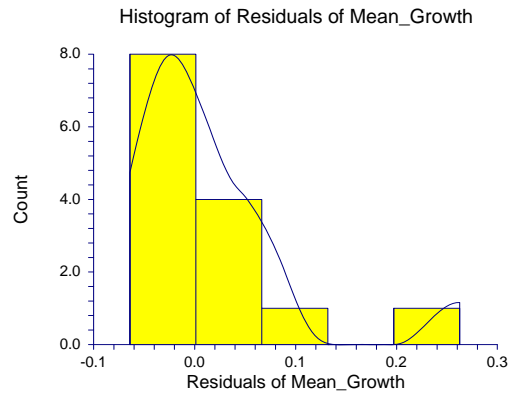
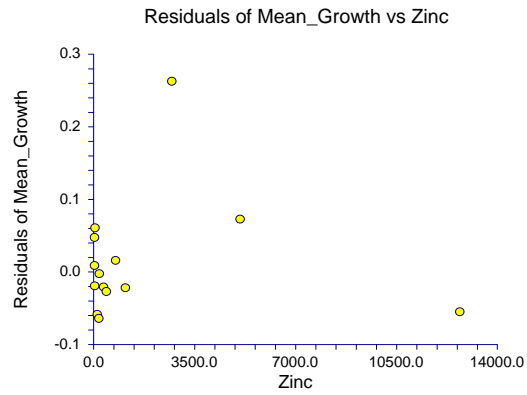
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:49:46 AM

Database

Y = Mean_Growth X = Zinc

Residual Plots Section



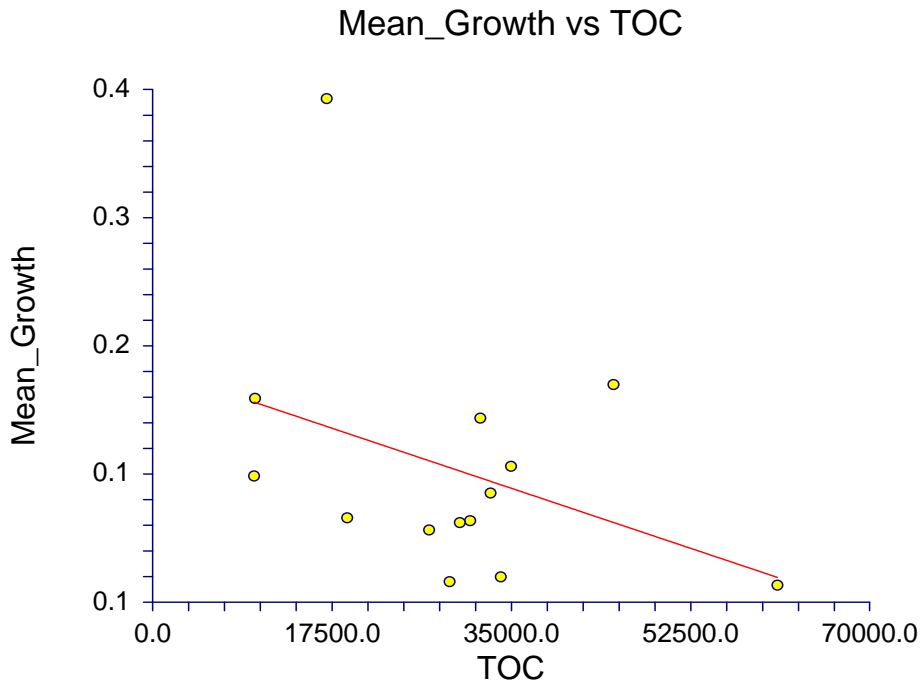
Linear Regression Report

Page/Date/Time 1 8/17/2009 11:50:49 AM

Database

Y = Mean_Growth X = TOC

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	TOC	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1869	Rows Prediction Only	1
Slope	0.0000	Sum of Frequencies	14
R-Squared	0.1364	Sum of Weights	14.0000
Correlation	-0.3693	Coefficient of Variation	0.5523
Mean Square Error	4.976164E-03	Square Root of MSE	7.054193E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:50:49 AM
Y = Mean_Growth X = TOC

Summary Statement

The equation of the straight line relating Mean_Growth and TOC is estimated as: $\text{Mean_Growth} = (0.1869) + (0.0000) \text{ TOC}$ using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when TOC is zero, is 0.1869 with a standard error of 0.0469. The slope, the estimated change in Mean_Growth per unit change in TOC, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in TOC, is 0.1364. The correlation between Mean_Growth and TOC is -0.3693.

A significance test that the slope is zero resulted in a t-value of -1.3766. The significance level of this t-test is 0.1938. Since $0.1938 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1869. The lower limit of the 95% confidence interval for the intercept is 0.0846 and the upper limit is 0.2892.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	TOC
Count	14	14
Mean	0.1277	29492.8571
Standard Deviation	0.0729	13420.4473
Minimum	0.0599	9900.0000
Maximum	0.3446	61000.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:50:49 AM

Database

Y = Mean_Growth X = TOC

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1869	0.0000
Lower 95% Confidence Limit	0.0846	0.0000
Upper 95% Confidence Limit	0.2892	0.0000
Standard Error	0.0469	0.0000
Standardized Coefficient	0.0000	-0.3693
T Value	3.9814	-1.3766
Prob Level (T Test)	0.0018	0.1938
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9542	0.2451
Regression of Y on X	0.1869	0.0000
Inverse Regression from X on Y	0.5617	0.0000
Orthogonal Regression of Y and X	0.1869	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.18691568094063) + (-2.00682861024176E-06) * (TOC)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2284042	0.2284042			
Slope	1	9.429701E-03	9.429701E-03	1.8950	0.1938	0.2451
Error	12	5.971397E-02	4.976164E-03			
Adj. Total	13	6.914367E-02	5.318744E-03			
Total	14	0.2975479				

s = Square Root(4.976164E-03) = 7.054193E-02

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:50:49 AM

Database

Y = Mean_Growth X = TOC

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8026	0.005369	No
Anderson Darling	0.9712	0.014507	No
D'Agostino Skewness	2.9941	0.002753	No
D'Agostino Kurtosis	2.5188	0.011775	No
D'Agostino Omnibus	15.3090	0.000474	No
Constant Residual Variance?			
Modified Levene Test	0.2089	0.655804	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

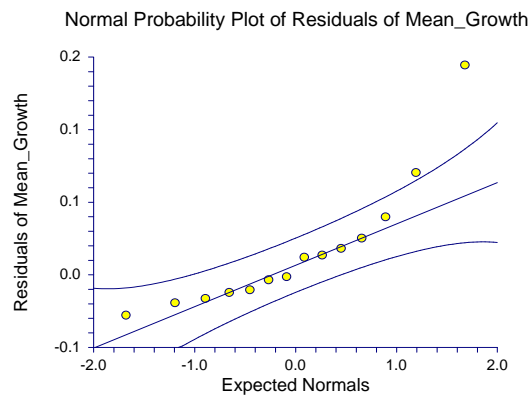
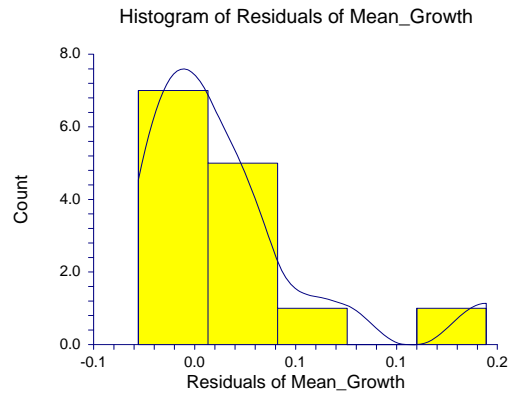
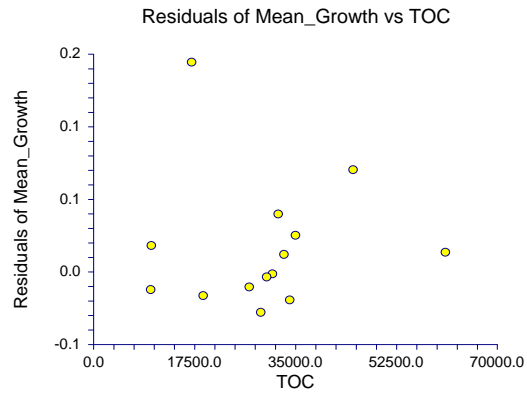
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 11:50:49 AM
Database
Y = Mean_Growth X = TOC

Residual Plots Section



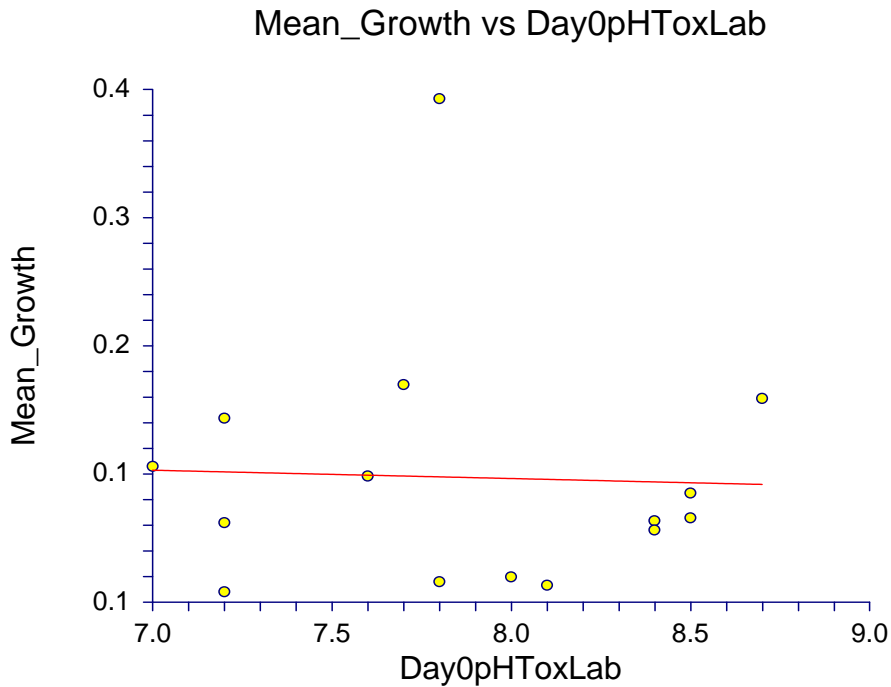
Linear Regression Report

Page/Date/Time 1 8/17/2009 11:50:08 AM

Database

Y = Mean_Growth X = Day0pHToxLab

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Day0pHToxLab	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1614	Rows Prediction Only	1
Slope	-0.0049	Sum of Frequencies	15
R-Squared	0.0014	Sum of Weights	15.0000
Correlation	-0.0374	Coefficient of Variation	0.6129
Mean Square Error	5.679159E-03	Square Root of MSE	7.536019E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:50:08 AM
Y = Mean_Growth X = Day0pHToxLab

Summary Statement

The equation of the straight line relating Mean_Growth and Day0pHToxLab is estimated as:
 $\text{Mean_Growth} = (0.1614) + (-0.0049) \text{Day0pHToxLab}$ using the 15 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Day0pHToxLab is zero, is 0.1614 with a standard error of 0.2858. The slope, the estimated change in Mean_Growth per unit change in Day0pHToxLab, is -0.0049 with a standard error of 0.0362. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Day0pHToxLab, is 0.0014. The correlation between Mean_Growth and Day0pHToxLab is -0.0374.

A significance test that the slope is zero resulted in a t-value of -0.1348. The significance level of this t-test is 0.8948. Since $0.8948 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0049. The lower limit of the 95% confidence interval for the slope is -0.0831 and the upper limit is 0.0734. The estimated intercept is 0.1614. The lower limit of the 95% confidence interval for the intercept is -0.4561 and the upper limit is 0.7789.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Day0pHToxLab
Count	15	15
Mean	0.1230	7.8733
Standard Deviation	0.0727	0.5561
Minimum	0.0561	7.0000
Maximum	0.3446	8.7000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:50:08 AM

Database

Y = Mean_Growth X = Day0pHToxLab

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1614	-0.0049
Lower 95% Confidence Limit	-0.4561	-0.0831
Upper 95% Confidence Limit	0.7789	0.0734
Standard Error	0.2858	0.0362
Standardized Coefficient	0.0000	-0.0374
T Value	0.5647	-0.1348
Prob Level (T Test)	0.5819	0.8948
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.0820	0.0518
Regression of Y on X	0.1614	-0.0049
Inverse Regression from X on Y	27.6599	-3.4975
Orthogonal Regression of Y and X	0.1621	-0.0050

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.161396150292575) + (-4.88266091776992E-03) * (Day0pHToxLab)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2267628	0.2267628			
Slope	1	1.032129E-04	1.032129E-04	0.0182	0.8948	0.0518
Error	13	7.382906E-02	5.679159E-03			
Lack of Fit	8	2.855489E-02	3.569362E-03	0.3942	0.8838	
Pure Error	5	4.527417E-02	9.054834E-03			
Adj. Total	14	7.393228E-02	5.280877E-03			
Total	15	0.3006951				

$s = \text{Square Root}(5.679159E-03) = 7.536019E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:50:08 AM

Database

Y = Mean_Growth X = Day0pHToxLab

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7819	0.002174	No
Anderson Darling	1.0171	0.011180	No
D'Agostino Skewness	3.2707	0.001073	No
D'Agostino Kurtosis	2.9442	0.003238	No
D'Agostino Omnibus	19.3658	0.000062	No

Constant Residual Variance?

Modified Levene Test	1.4753	0.246120	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(8, 5) Test	0.3942	0.883761	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

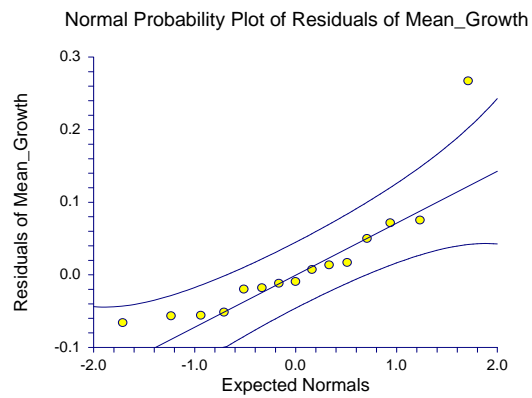
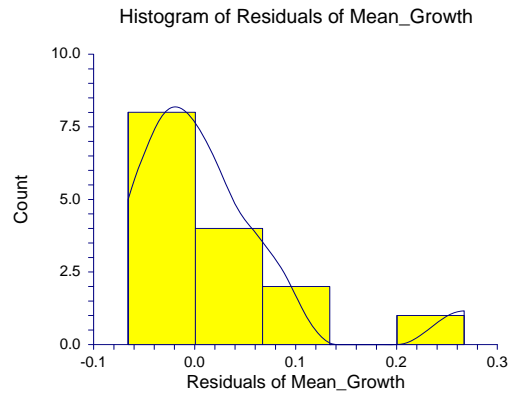
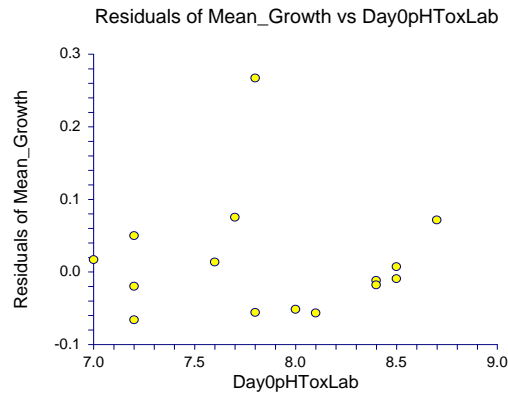
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:50:08 AM

Database

Y = Mean_Growth X = Day0pHToxLab

Residual Plots Section



Linear Regression Report

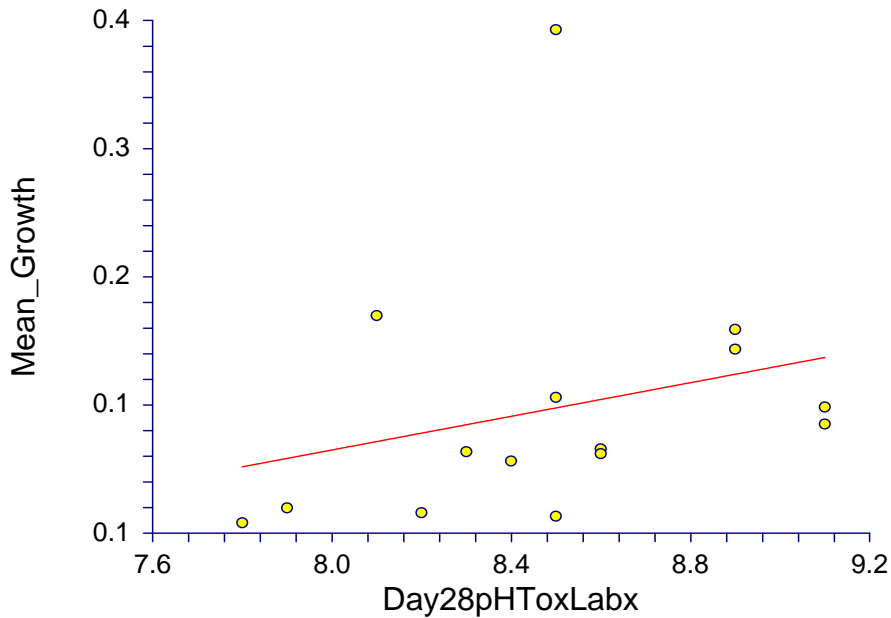
Page/Date/Time 1 8/17/2009 11:50:25 AM

Database

Y = Mean_Growth X = Day28pHToxLabx

Linear Regression Plot Section

Mean_Growth vs Day28pHToxLabx



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Day28pHToxLabx	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	-0.2950	Rows Prediction Only	1
Slope	0.0492	Sum of Frequencies	15
R-Squared	0.0724	Sum of Weights	15.0000
Correlation	0.2690	Coefficient of Variation	0.5907
Mean Square Error	5.275516E-03	Square Root of MSE	7.263274E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:50:25 AM
Y = Mean_Growth X = Day28pHToxLabx

Summary Statement

The equation of the straight line relating Mean_Growth and Day28pHToxLabx is estimated as:
 $\text{Mean_Growth} = (-0.2950) + (0.0492) \text{ Day28pHToxLabx}$ using the 15 observations in this dataset.
The y-intercept, the estimated value of Mean_Growth when Day28pHToxLabx is zero, is -0.2950 with a standard error of 0.4155. The slope, the estimated change in Mean_Growth per unit change in Day28pHToxLabx, is 0.0492 with a standard error of 0.0489. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Day28pHToxLabx, is 0.0724. The correlation between Mean_Growth and Day28pHToxLabx is 0.2690.

A significance test that the slope is zero resulted in a t-value of 1.0071. The significance level of this t-test is 0.3323. Since $0.3323 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0492. The lower limit of the 95% confidence interval for the slope is -0.0564 and the upper limit is 0.1548. The estimated intercept is -0.2950. The lower limit of the 95% confidence interval for the intercept is -1.1926 and the upper limit is 0.6025.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Day28pHToxLabx
Count	15	15
Mean	0.1230	8.4933
Standard Deviation	0.0727	0.3973
Minimum	0.0561	7.8000
Maximum	0.3446	9.1000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:50:25 AM

Database

Y = Mean_Growth X = Day28pHToxLabx

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-0.2950	0.0492
Lower 95% Confidence Limit	-1.1926	-0.0564
Upper 95% Confidence Limit	0.6025	0.1548
Standard Error	0.4155	0.0489
Standardized Coefficient	0.0000	0.2690
T Value	-0.7101	1.0071
Prob Level (T Test)	0.4902	0.3323
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.1010	0.1544
Regression of Y on X	-0.2950	0.0492
Inverse Regression from X on Y	-5.6524	0.6800
Orthogonal Regression of Y and X	-0.3084	0.0508

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(-.295019130959549) + (.049211828605913) * (\text{Day28pHToxLabx})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2267628	0.2267628			
Slope	1	5.350573E-03	5.350573E-03	1.0142	0.3323	0.1544
Error	13	6.858171E-02	5.275516E-03			
Lack of Fit	8	2.440508E-02	3.050636E-03	0.3453	0.9122	
Pure Error	5	4.417662E-02	8.835324E-03			
Adj. Total	14	7.393228E-02	5.280877E-03			
Total	15	0.3006951				

$s = \text{Square Root}(5.275516\text{E-}03) = 7.263274\text{E-}02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:50:25 AM

Database

Y = Mean_Growth X = Day28pHToxLabx

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6927	0.000208	No
Anderson Darling	1.7299	0.000198	No
D'Agostino Skewness	3.6888	0.000225	No
D'Agostino Kurtosis	3.2462	0.001170	No
D'Agostino Omnibus	24.1450	0.000006	No

Constant Residual Variance?

Modified Levene Test	0.5570	0.468769	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(8, 5) Test	0.3453	0.912246	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

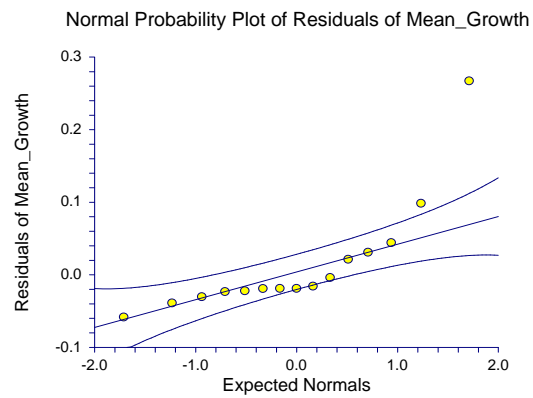
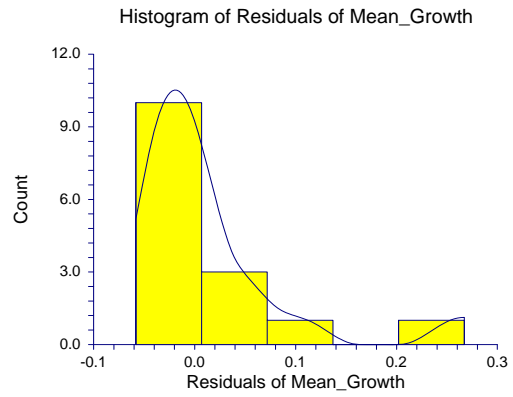
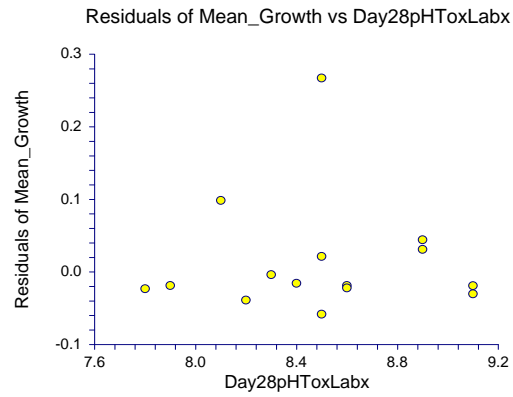
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:50:25 AM

Database

Y = Mean_Growth X = Day28pHToxLabx

Residual Plots Section



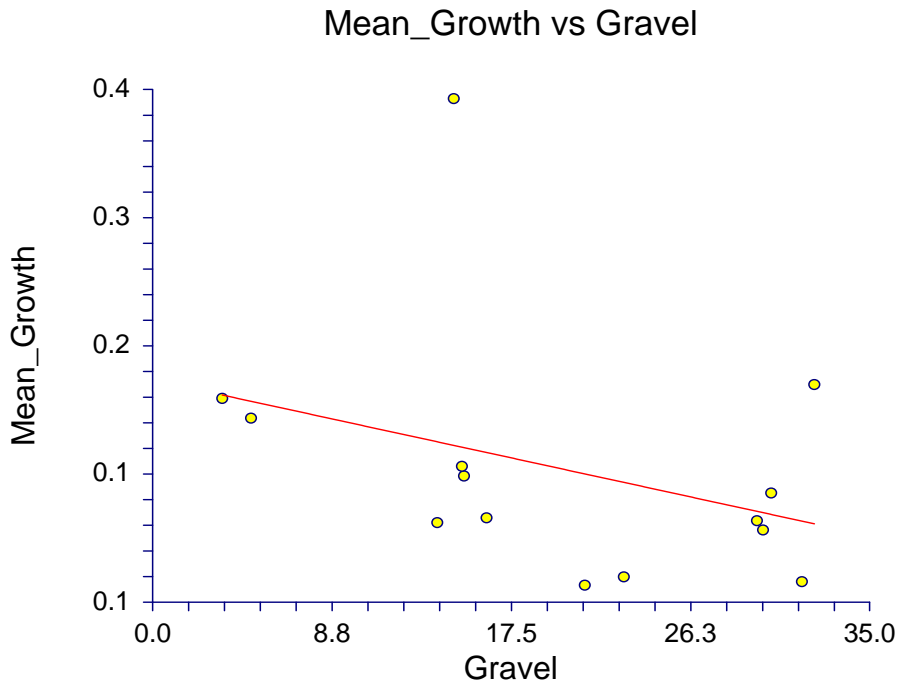
Linear Regression Report

Page/Date/Time 1 8/17/2009 11:51:05 AM

Database

Y = Mean_Growth X = Gravel

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Gravel	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1801	Rows Prediction Only	1
Slope	-0.0026	Sum of Frequencies	14
R-Squared	0.1201	Sum of Weights	14.0000
Correlation	-0.3465	Coefficient of Variation	0.5575
Mean Square Error	5.070119E-03	Square Root of MSE	7.120477E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:51:05 AM
Y = Mean_Growth X = Gravel

Summary Statement

The equation of the straight line relating Mean_Growth and Gravel is estimated as: $\text{Mean_Growth} = (0.1801) + (-0.0026) \text{Gravel}$ using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Gravel is zero, is 0.1801 with a standard error of 0.0451. The slope, the estimated change in Mean_Growth per unit change in Gravel, is -0.0026 with a standard error of 0.0020. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Gravel, is 0.1201. The correlation between Mean_Growth and Gravel is -0.3465.

A significance test that the slope is zero resulted in a t-value of -1.2796. The significance level of this t-test is 0.2249. Since $0.2249 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0026. The lower limit of the 95% confidence interval for the slope is -0.0070 and the upper limit is 0.0018. The estimated intercept is 0.1801. The lower limit of the 95% confidence interval for the intercept is 0.0818 and the upper limit is 0.2783.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Gravel
Count	14	14
Mean	0.1277	20.0714
Standard Deviation	0.0729	9.6925
Minimum	0.0599	3.4000
Maximum	0.3446	32.3000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:51:05 AM

Database

Y = Mean_Growth X = Gravel

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1801	-0.0026
Lower 95% Confidence Limit	0.0818	-0.0070
Upper 95% Confidence Limit	0.2783	0.0018
Standard Error	0.0451	0.0020
Standardized Coefficient	0.0000	-0.3465
T Value	3.9919	-1.2796
Prob Level (T Test)	0.0018	0.2249
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9551	0.2182
Regression of Y on X	0.1801	-0.0026
Inverse Regression from X on Y	0.5636	-0.0217
Orthogonal Regression of Y and X	0.1801	-0.0026

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(.180060525767866) + (-2.60728598131716E-03) * (\text{Gravel})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2284042	0.2284042			
Slope	1	8.302246E-03	8.302246E-03	1.6375	0.2249	0.2182
Error	12	6.084142E-02	5.070119E-03			
Adj. Total	13	6.914367E-02	5.318744E-03			
Total	14	0.2975479				

$s = \text{Square Root}(5.070119E-03) = 7.120477E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:51:05 AM

Database

Y = Mean_Growth X = Gravel

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7357	0.000889	No
Anderson Darling	1.4174	0.001158	No
D'Agostino Skewness	3.3624	0.000773	No
D'Agostino Kurtosis	2.9242	0.003453	No
D'Agostino Omnibus	19.8567	0.000049	No
Constant Residual Variance?			
Modified Levene Test	0.0488	0.828820	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

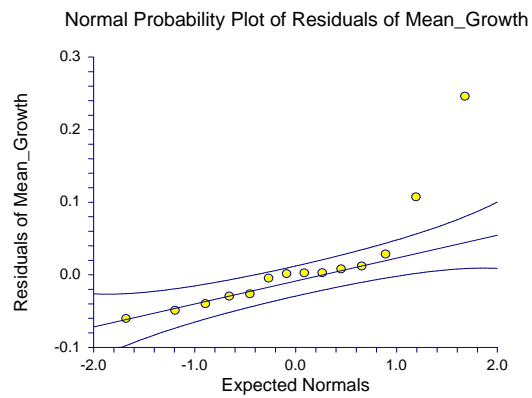
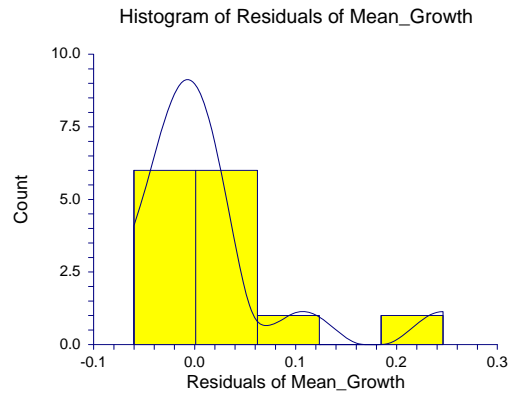
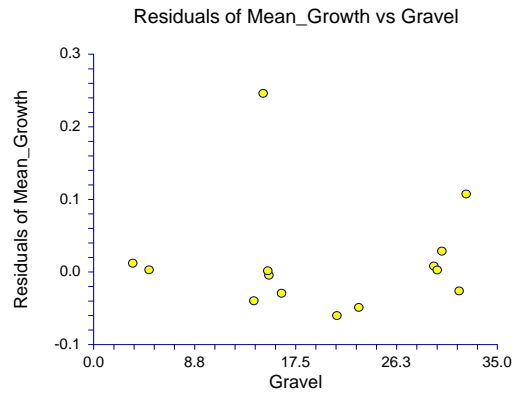
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:51:05 AM

Database

Y = Mean_Growth X = Gravel

Residual Plots Section



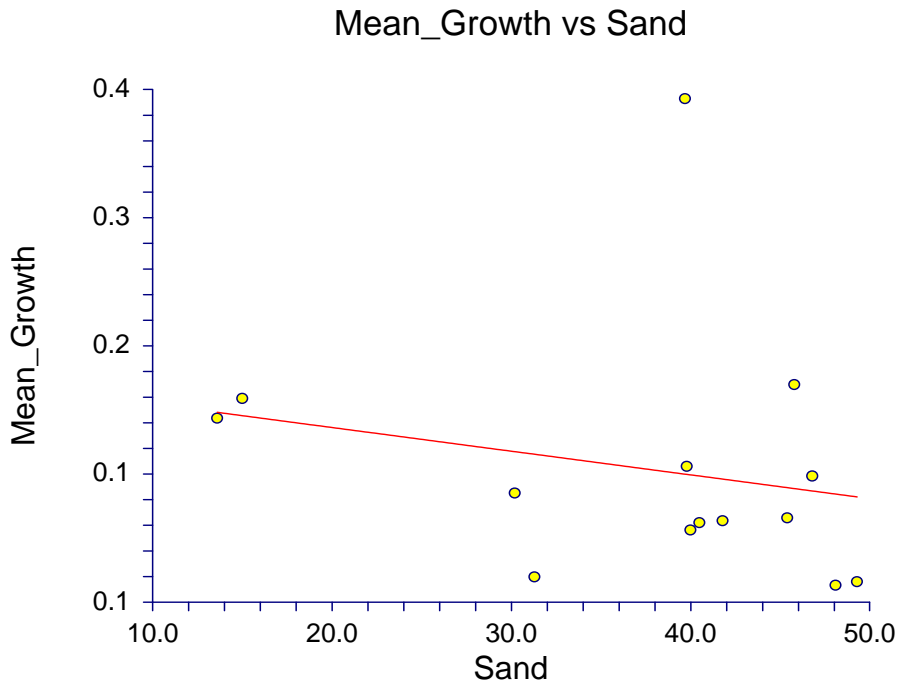
Linear Regression Report

Page/Date/Time 1 8/17/2009 11:51:26 AM

Database

Y = Mean_Growth X = Sand

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Sand	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1799	Rows Prediction Only	1
Slope	-0.0014	Sum of Frequencies	14
R-Squared	0.0467	Sum of Weights	14.0000
Correlation	-0.2160	Coefficient of Variation	0.5803
Mean Square Error	5.493037E-03	Square Root of MSE	7.411503E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:51:26 AM
Y = Mean_Growth X = Sand

Summary Statement

The equation of the straight line relating Mean_Growth and Sand is estimated as: $\text{Mean_Growth} = (0.1799) + (-0.0014) \text{ Sand}$ using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Sand is zero, is 0.1799 with a standard error of 0.0709. The slope, the estimated change in Mean_Growth per unit change in Sand, is -0.0014 with a standard error of 0.0018. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Sand, is 0.0467. The correlation between Mean_Growth and Sand is -0.2160.

A significance test that the slope is zero resulted in a t-value of -0.7665. The significance level of this t-test is 0.4582. Since $0.4582 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0014. The lower limit of the 95% confidence interval for the slope is -0.0053 and the upper limit is 0.0026. The estimated intercept is 0.1799. The lower limit of the 95% confidence interval for the intercept is 0.0254 and the upper limit is 0.3343.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Sand
Count	14	14
Mean	0.1277	37.6643
Standard Deviation	0.0729	11.3750
Minimum	0.0599	13.6000
Maximum	0.3446	49.3000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:51:26 AM

Database

Y = Mean_Growth X = Sand

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1799	-0.0014
Lower 95% Confidence Limit	0.0254	-0.0053
Upper 95% Confidence Limit	0.3343	0.0026
Standard Error	0.0709	0.0018
Standardized Coefficient	0.0000	-0.2160
T Value	2.5378	-0.7665
Prob Level (T Test)	0.0260	0.4582
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.6450	0.1089
Regression of Y on X	0.1799	-0.0014
Inverse Regression from X on Y	1.2455	-0.0297
Orthogonal Regression of Y and X	0.1799	-0.0014

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.179898663086049) + (-1.3851342370656E-03) * (Sand)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2284042	0.2284042			
Slope	1	3.227218E-03	3.227218E-03	0.5875	0.4582	0.1089
Error	12	6.591645E-02	5.493037E-03			
Adj. Total	13	6.914367E-02	5.318744E-03			
Total	14	0.2975479				

$s = \text{Square Root}(5.493037E-03) = 7.411503E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:51:26 AM

Database

Y = Mean_Growth X = Sand

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7252	0.000682	No
Anderson Darling	1.3871	0.001375	No
D'Agostino Skewness	3.5721	0.000354	No
D'Agostino Kurtosis	3.2256	0.001257	No
D'Agostino Omnibus	23.1641	0.000009	No
Constant Residual Variance?			
Modified Levene Test	0.6613	0.431954	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

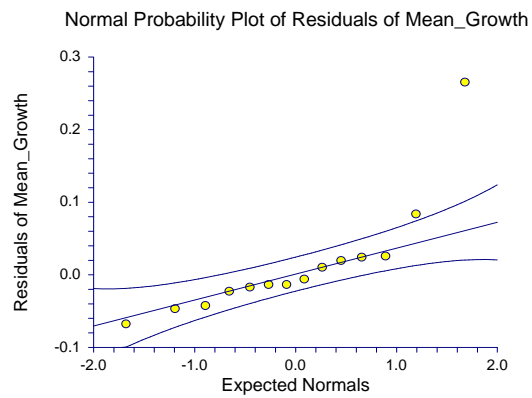
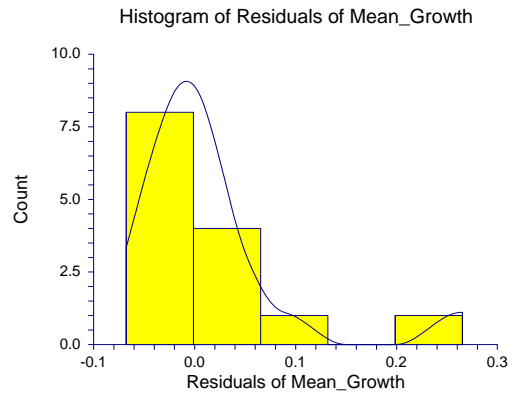
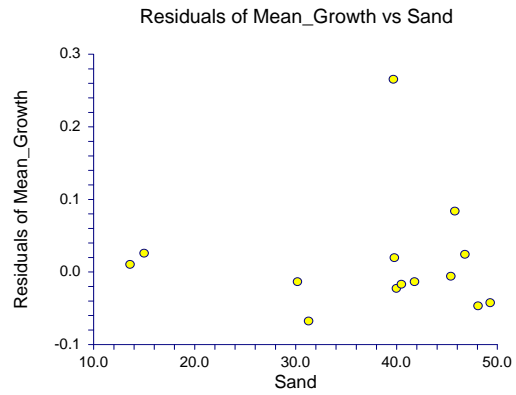
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:51:26 AM

Database

Y = Mean_Growth X = Sand

Residual Plots Section



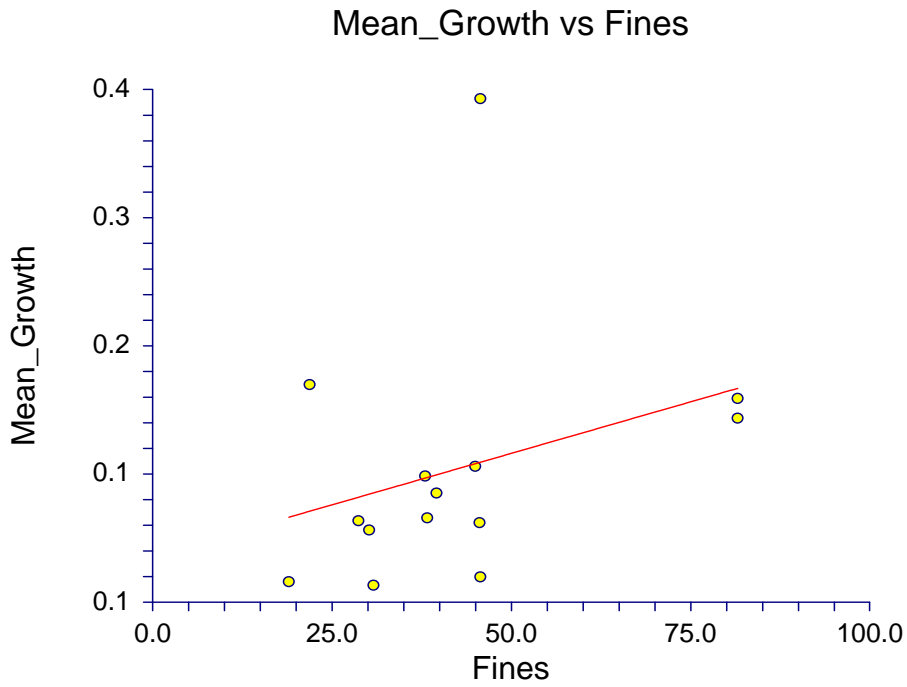
Linear Regression Report

Page/Date/Time 1 8/17/2009 11:51:44 AM

Database

Y = Mean_Growth X = Fines

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Independent Variable	Fines	Rows Used in Estimation	14
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0768	Rows Prediction Only	1
Slope	0.0012	Sum of Frequencies	14
R-Squared	0.0965	Sum of Weights	14.0000
Correlation	0.3106	Coefficient of Variation	0.5649
Mean Square Error	5.206198E-03	Square Root of MSE	7.215399E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 11:51:44 AM
Y = Mean_Growth X = Fines

Summary Statement

The equation of the straight line relating Mean_Growth and Fines is estimated as: $\text{Mean_Growth} = (0.0768) + (0.0012) \text{Fines}$ using the 14 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Fines is zero, is 0.0768 with a standard error of 0.0489. The slope, the estimated change in Mean_Growth per unit change in Fines, is 0.0012 with a standard error of 0.0011. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Fines, is 0.0965. The correlation between Mean_Growth and Fines is 0.3106.

A significance test that the slope is zero resulted in a t-value of 1.1318. The significance level of this t-test is 0.2798. Since $0.2798 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0012. The lower limit of the 95% confidence interval for the slope is -0.0011 and the upper limit is 0.0035. The estimated intercept is 0.0768. The lower limit of the 95% confidence interval for the intercept is -0.0298 and the upper limit is 0.1835.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Fines
Count	14	14
Mean	0.1277	42.2643
Standard Deviation	0.0729	18.8000
Minimum	0.0599	19.0000
Maximum	0.3446	81.6000

Linear Regression Report

Page/Date/Time 3 8/17/2009 11:51:44 AM

Database

Y = Mean_Growth X = Fines

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0768	0.0012
Lower 95% Confidence Limit	-0.0298	-0.0011
Upper 95% Confidence Limit	0.1835	0.0035
Standard Error	0.0489	0.0011
Standardized Coefficient	0.0000	0.3106
T Value	1.5692	1.1318
Prob Level (T Test)	0.1426	0.2798
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.3035	0.1809
Regression of Y on X	0.0768	0.0012
Inverse Regression from X on Y	-0.4002	0.0125
Orthogonal Regression of Y and X	0.0768	0.0012

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(7.68090650323656E-02) + (1.20478805061159E-03) * (\text{Fines})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	0.2284042	0.2284042			
Slope	1	6.66929E-03	6.66929E-03	1.2810	0.2798	0.1809
Error	12	6.247438E-02	5.206198E-03			
Lack of Fit	10	2.326308E-02	2.326308E-03	0.1187	0.9928	
Pure Error	2	0.0392113	1.960565E-02			
Adj. Total	13	6.914367E-02	5.318744E-03			
Total	14	0.2975479				

$s = \text{Square Root}(5.206198E-03) = 7.215399E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 11:51:44 AM

Database

Y = Mean_Growth X = Fines

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6933	0.000315	No
Anderson Darling	1.6987	0.000236	No
D'Agostino Skewness	3.6065	0.000310	No
D'Agostino Kurtosis	3.1927	0.001409	No
D'Agostino Omnibus	23.2002	0.000009	No

Constant Residual Variance?

Modified Levene Test	0.4156	0.531272	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(10, 2) Test	0.1187	0.992841	Yes
----------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

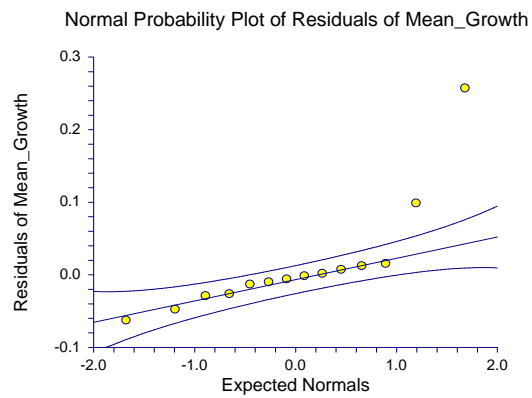
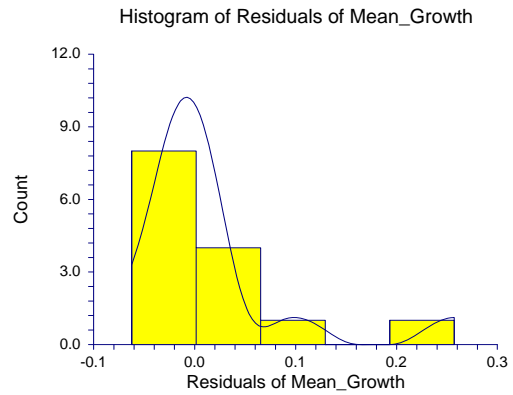
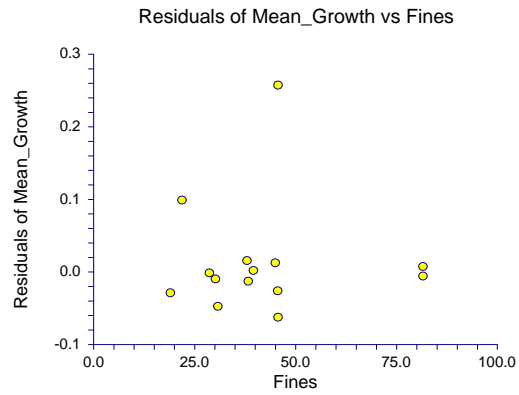
Linear Regression Report

Page/Date/Time 5 8/17/2009 11:51:44 AM

Database

Y = Mean_Growth X = Fines

Residual Plots Section



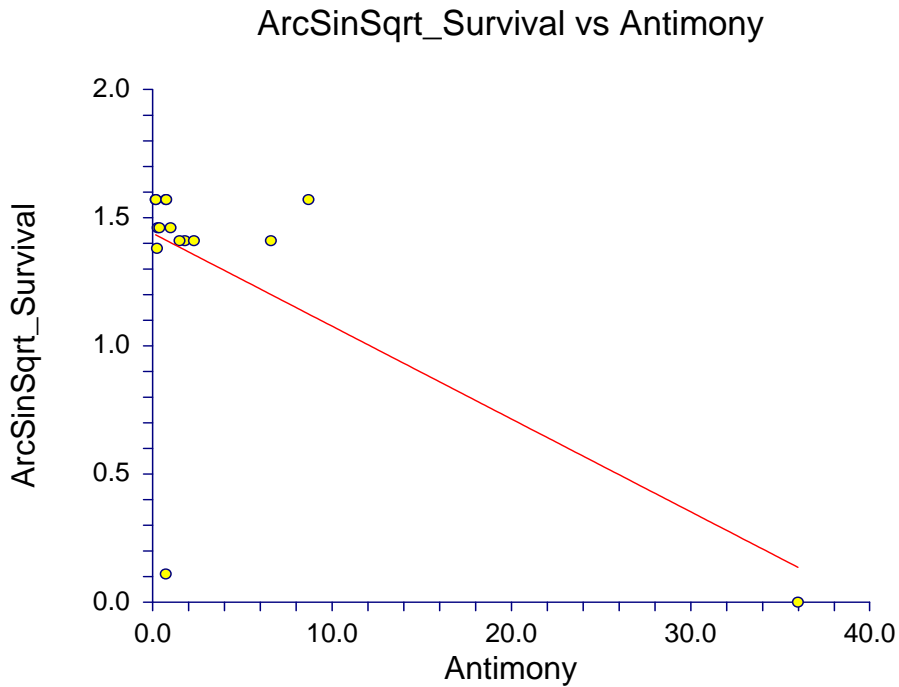
Linear Regression Report

Page/Date/Time 1 8/17/2009 8:37:25 AM

Database

Y = ArcSinSqrt_Survival X = Antimony

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Antimony	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4387	Rows Prediction Only	0
Slope	-0.0362	Sum of Frequencies	15
R-Squared	0.4283	Sum of Weights	15.0000
Correlation	-0.6544	Coefficient of Variation	0.3083
Mean Square Error	0.1583605	Square Root of MSE	0.3979453

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:37:25 AM

Y = ArcSinSqrt_Survival X = Antimony

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Antimony is estimated as:
 $\text{ArcSinSqrt_Survival} = (1.4387) + (-0.0362) \text{ Antimony}$ using the 15 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when Antimony is zero, is 1.4387 with a standard error of 0.1132. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Antimony, is -0.0362 with a standard error of 0.0116. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Antimony, is 0.4283. The correlation between ArcSinSqrt_Survival and Antimony is -0.6544.

A significance test that the slope is zero resulted in a t-value of -3.1207. The significance level of this t-test is 0.0081. Since $0.0081 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is -0.0362. The lower limit of the 95% confidence interval for the slope is -0.0612 and the upper limit is -0.0111. The estimated intercept is 1.4387. The lower limit of the 95% confidence interval for the intercept is 1.1942 and the upper limit is 1.6832.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Antimony
Count	15	15
Mean	1.2907	4.0920
Standard Deviation	0.5072	9.1724
Minimum	0.0000	0.1700
Maximum	1.5700	36.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:37:25 AM

Database

Y = ArcSinSqrt_Survival X = Antimony

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4387	-0.0362
Lower 95% Confidence Limit	1.1942	-0.0612
Upper 95% Confidence Limit	1.6832	-0.0111
Standard Error	0.1132	0.0116
Standardized Coefficient	0.0000	-0.6544
T Value	12.7125	-3.1207
Prob Level (T Test)	0.0000	0.0081
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	1.0000	0.8222
Regression of Y on X	1.4387	-0.0362
Inverse Regression from X on Y	1.6364	-0.0845
Orthogonal Regression of Y and X	1.4390	-0.0362

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.43873413421662) + (-3.61846206133814E-02) * (Antimony)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	24.98731	24.98731			
Slope	1	1.542207	1.542207	9.7386	0.0081	0.8222
Error	13	2.058686	0.1583605			
Adj. Total	14	3.600893	0.2572067			
Total	15	28.5882				

s = Square Root(0.1583605) = 0.3979453

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:37:25 AM

Database

Y = ArcSinSqrt_Survival X = Antimony

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6051	0.000028	No
Anderson Darling	2.3279	0.000007	No
D'Agostino Skewness	-4.1503	0.000033	No
D'Agostino Kurtosis	3.8007	0.000144	No
D'Agostino Omnibus	31.6699	0.000000	No
Constant Residual Variance?			
Modified Levene Test	0.4384	0.519472	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

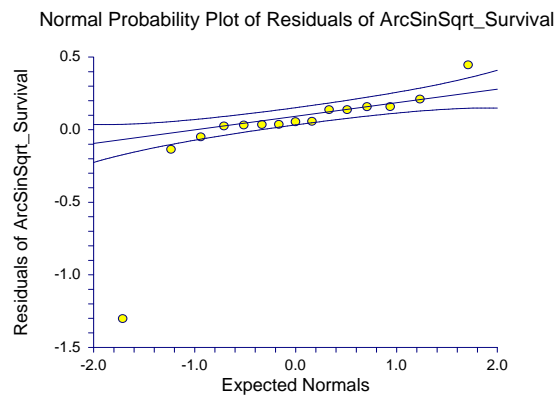
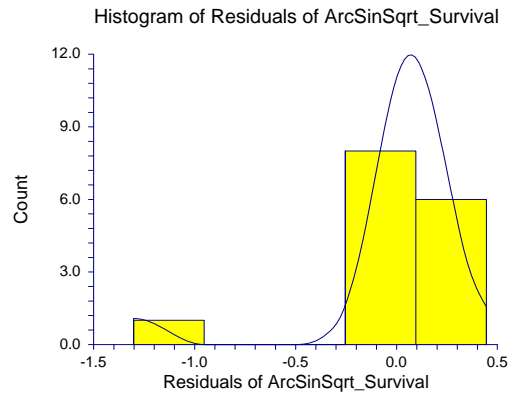
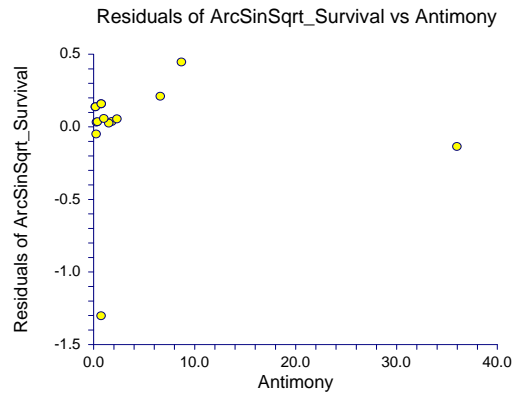
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:37:25 AM

Database

Y = ArcSinSqrt_Survival X = Antimony

Residual Plots Section



Linear Regression Report

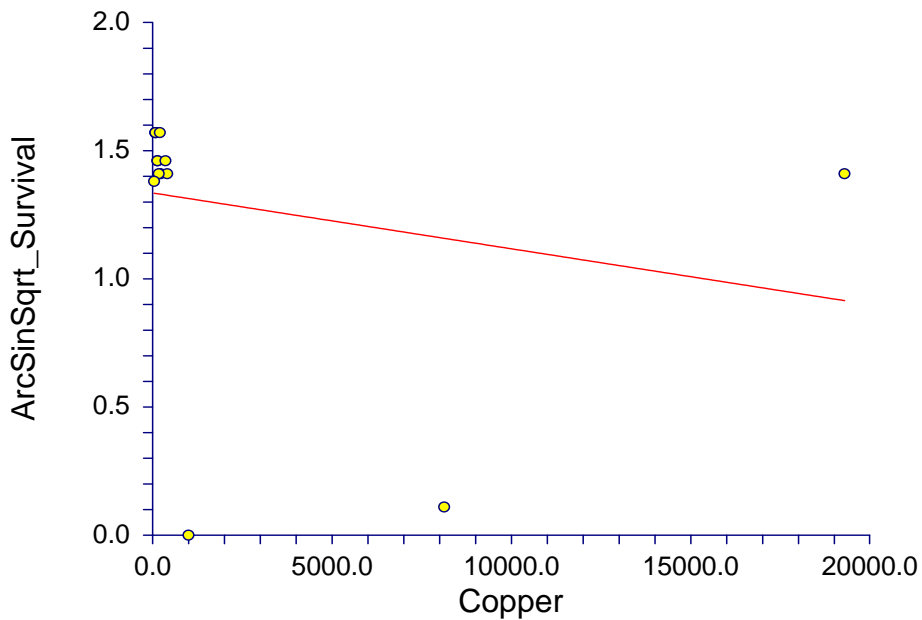
Page/Date/Time 1 8/17/2009 8:38:57 AM

Database

Y = ArcSinSqrt_Survival X = Copper

Linear Regression Plot Section

ArcSinSqrt_Survival vs Copper



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Copper	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.3348	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	15
R-Squared	0.0497	Sum of Weights	15.0000
Correlation	-0.2230	Coefficient of Variation	0.3975
Mean Square Error	0.2632117	Square Root of MSE	0.5130416

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:38:57 AM

Y = ArcSinSqrt_Survival X = Copper

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Copper is estimated as:
 $\text{ArcSinSqrt_Survival} = (1.3348) + (0.0000) \text{ Copper}$ using the 15 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when Copper is zero, is 1.3348 with a standard error of 0.1429. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Copper, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Copper, is 0.0497. The correlation between ArcSinSqrt_Survival and Copper is -0.2230.

A significance test that the slope is zero resulted in a t-value of -0.8250. The significance level of this t-test is 0.4243. Since $0.4243 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is -0.0001 and the upper limit is 0.0000. The estimated intercept is 1.3348. The lower limit of the 95% confidence interval for the intercept is 1.0262 and the upper limit is 1.6435.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Copper
Count	15	15
Mean	1.2907	2028.6067
Standard Deviation	0.5072	5198.4637
Minimum	0.0000	41.0000
Maximum	1.5700	19300.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:38:57 AM

Database

Y = ArcSinSqrt_Survival X = Copper

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.3348	0.0000
Lower 95% Confidence Limit	1.0262	-0.0001
Upper 95% Confidence Limit	1.6435	0.0000
Standard Error	0.1429	0.0000
Standardized Coefficient	0.0000	-0.2230
T Value	9.3431	-0.8250
Prob Level (T Test)	0.0000	0.4243
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1194
Regression of Y on X	1.3348	0.0000
Inverse Regression from X on Y	2.1780	-0.0004
Orthogonal Regression of Y and X	1.3348	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.33480914324384) + (-2.17599977869077E-05) * (Copper)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	24.98731	24.98731			
Slope	1	0.1791413	0.1791413	0.6806	0.4243	0.1194
Error	13	3.421752	0.2632117			
Adj. Total	14	3.600893	0.2572067			
Total	15	28.5882				

$s = \text{Square Root}(0.2632117) = 0.5130416$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:38:57 AM

Database

Y = ArcSinSqrt_Survival X = Copper

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6311	0.000050	No
Anderson Darling	2.6002	0.000001	No
D'Agostino Skewness	-3.3002	0.000966	No
D'Agostino Kurtosis	2.4146	0.015755	No
D'Agostino Omnibus	16.7211	0.000234	No

Constant Residual Variance?

Modified Levene Test	3.4513	0.085995	No
----------------------	--------	----------	----

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

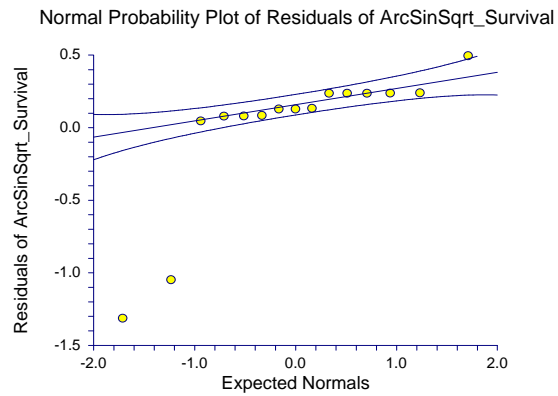
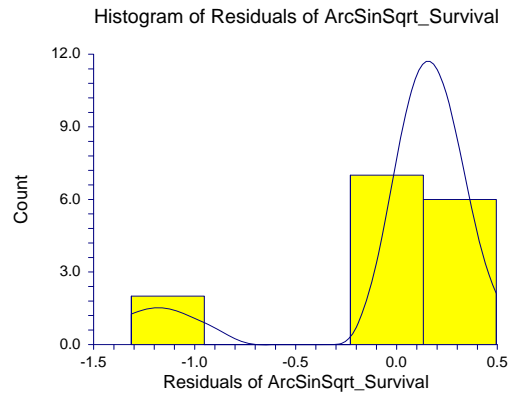
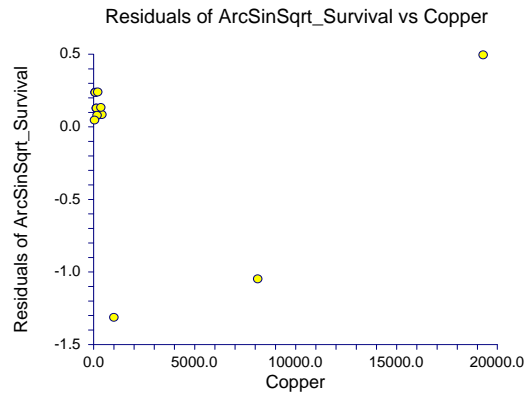
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:38:57 AM

Database

Y = ArcSinSqrt_Survival X = Copper

Residual Plots Section



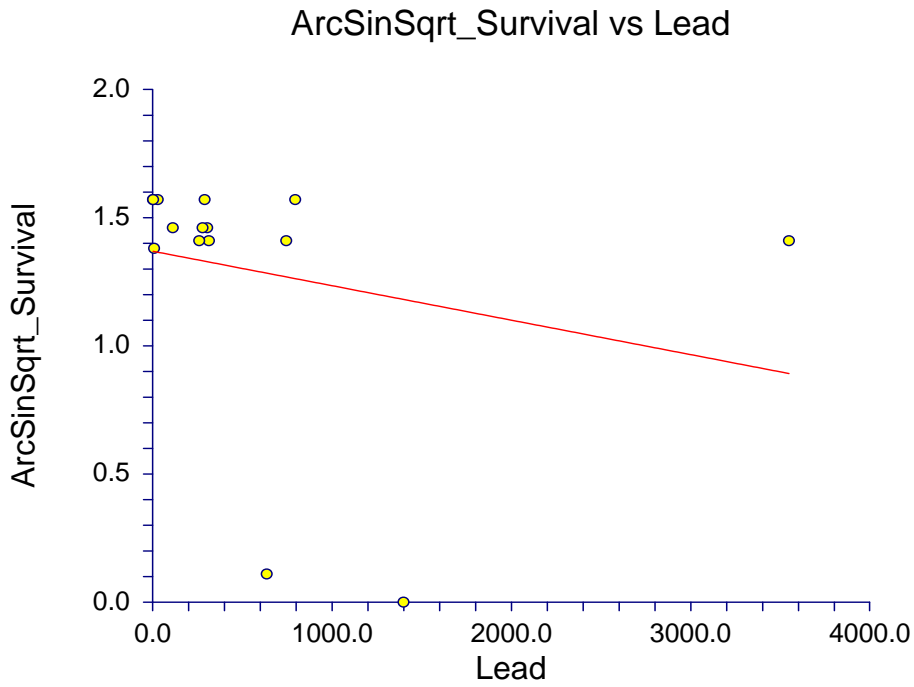
Linear Regression Report

Page/Date/Time 1 8/17/2009 8:39:23 AM

Database

Y = ArcSinSqrt_Survival X = Lead

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Lead	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.3689	Rows Prediction Only	0
Slope	-0.0001	Sum of Frequencies	15
R-Squared	0.0577	Sum of Weights	15.0000
Correlation	-0.2402	Coefficient of Variation	0.3958
Mean Square Error	0.2610068	Square Root of MSE	0.5108883

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:39:23 AM
Y = ArcSinSqrt_Survival X = Lead

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Lead is estimated as:
$$\text{ArcSinSqrt_Survival} = (1.3689) + (-0.0001) \text{ Lead}$$
using the 15 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when Lead is zero, is 1.3689 with a standard error of 0.1584. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Lead, is -0.0001 with a standard error of 0.0002. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Lead, is 0.0577. The correlation between ArcSinSqrt_Survival and Lead is -0.2402.

A significance test that the slope is zero resulted in a t-value of -0.8923. The significance level of this t-test is 0.3885. Since $0.3885 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0001. The lower limit of the 95% confidence interval for the slope is -0.0005 and the upper limit is 0.0002. The estimated intercept is 1.3689. The lower limit of the 95% confidence interval for the intercept is 1.0267 and the upper limit is 1.7110.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Lead
Count	15	15
Mean	1.2907	582.0800
Standard Deviation	0.5072	906.6975
Minimum	0.0000	2.1000
Maximum	1.5700	3550.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:39:23 AM

Database

Y = ArcSinSqrt_Survival X = Lead

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.3689	-0.0001
Lower 95% Confidence Limit	1.0267	-0.0005
Upper 95% Confidence Limit	1.7110	0.0002
Standard Error	0.1584	0.0002
Standardized Coefficient	0.0000	-0.2402
T Value	8.6430	-0.8923
Prob Level (T Test)	0.0000	0.3885
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1314
Regression of Y on X	1.3689	-0.0001
Inverse Regression from X on Y	2.6460	-0.0023
Orthogonal Regression of Y and X	1.3689	-0.0001

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.3688805118845) + (-1.34369580157076E-04) * (Lead)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	24.98731	24.98731			
Slope	1	0.2078044	0.2078044	0.7962	0.3885	0.1314
Error	13	3.393089	0.2610068			
Adj. Total	14	3.600893	0.2572067			
Total	15	28.5882				

$s = \text{Square Root}(0.2610068) = 0.5108883$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:39:23 AM

Database

Y = ArcSinSqrt_Survival X = Lead

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6377	0.000058	No
Anderson Darling	2.5438	0.000002	No
D'Agostino Skewness	-3.1983	0.001382	No
D'Agostino Kurtosis	2.2564	0.024047	No
D'Agostino Omnibus	15.3204	0.000471	No
Constant Residual Variance?			
Modified Levene Test	3.6019	0.080143	No
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

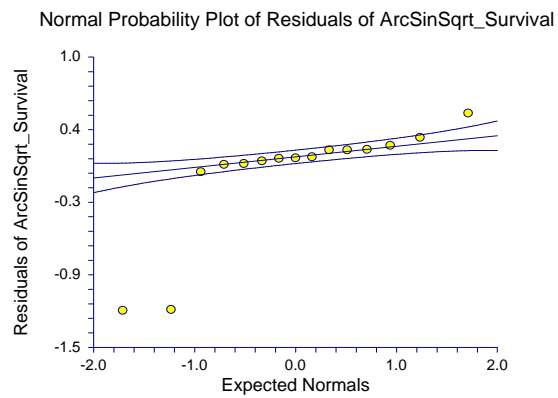
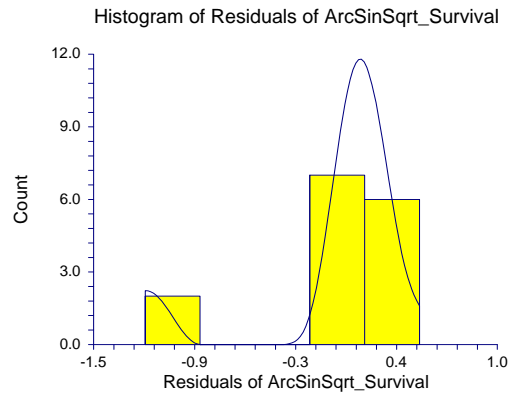
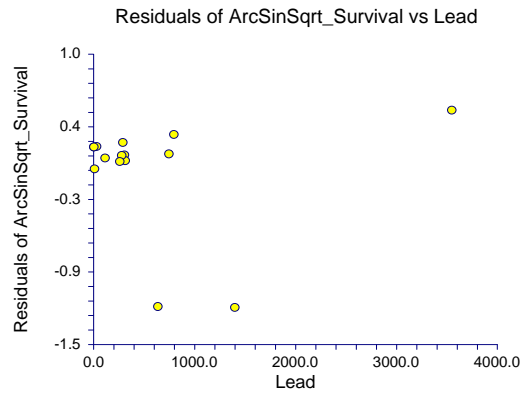
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:39:23 AM

Database

Y = ArcSinSqrt_Survival X = Lead

Residual Plots Section



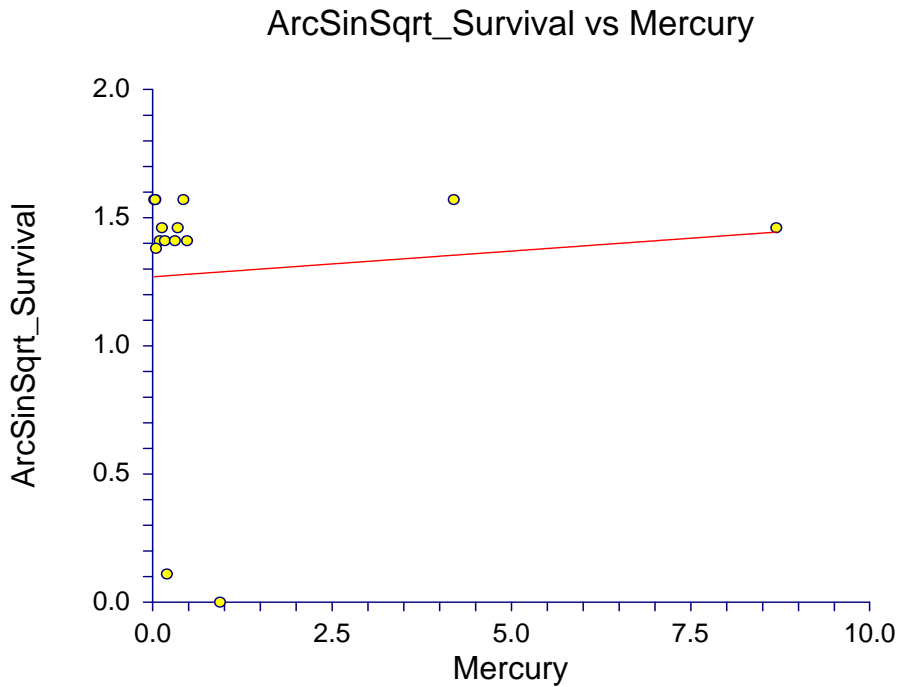
Linear Regression Report

Page/Date/Time 1 8/17/2009 8:39:41 AM

Database

Y = ArcSinSqrt_Survival X = Mercury

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Mercury	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.2691	Rows Prediction Only	0
Slope	0.0201	Sum of Frequencies	15
R-Squared	0.0087	Sum of Weights	15.0000
Correlation	0.0931	Coefficient of Variation	0.4060
Mean Square Error	0.2745906	Square Root of MSE	0.5240139

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:39:41 AM

Y = ArcSinSqrt_Survival X = Mercury

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Mercury is estimated as:
 $\text{ArcSinSqrt_Survival} = (1.2691) + (0.0201) \text{ Mercury}$ using the 15 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when Mercury is zero, is 1.2691 with a standard error of 0.1497. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Mercury, is 0.0201 with a standard error of 0.0595. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Mercury, is 0.0087. The correlation between ArcSinSqrt_Survival and Mercury is 0.0931.

A significance test that the slope is zero resulted in a t-value of 0.3372. The significance level of this t-test is 0.7414. Since $0.7414 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0201. The lower limit of the 95% confidence interval for the slope is -0.1085 and the upper limit is 0.1486. The estimated intercept is 1.2691. The lower limit of the 95% confidence interval for the intercept is 0.9456 and the upper limit is 1.5925.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Mercury
Count	15	15
Mean	1.2907	1.0769
Standard Deviation	0.5072	2.3536
Minimum	0.0000	0.0240
Maximum	1.5700	8.7000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:39:41 AM

Database

Y = ArcSinSqrt_Survival X = Mercury

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.2691	0.0201
Lower 95% Confidence Limit	0.9456	-0.1085
Upper 95% Confidence Limit	1.5925	0.1486
Standard Error	0.1497	0.0595
Standardized Coefficient	0.0000	0.0931
T Value	8.4770	0.3372
Prob Level (T Test)	0.0000	0.7414
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0613
Regression of Y on X	1.2691	0.0201
Inverse Regression from X on Y	-1.2016	2.3143
Orthogonal Regression of Y and X	1.2680	0.0210

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.26906223555131) + (2.00623083470804E-02) * (Mercury)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	24.98731	24.98731			
Slope	1	3.121517E-02	3.121517E-02	0.1137	0.7414	0.0613
Error	13	3.569678	0.2745906			
Adj. Total	14	3.600893	0.2572067			
Total	15	28.5882				

s = Square Root(0.2745906) = 0.5240139

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:39:41 AM

Database

Y = ArcSinSqrt_Survival X = Mercury

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.5692	0.000013	No
Anderson Darling	2.9565	0.000000	No
D'Agostino Skewness	-3.3973	0.000681	No
D'Agostino Kurtosis	2.4081	0.016037	No
D'Agostino Omnibus	17.3405	0.000172	No

Constant Residual Variance?

Modified Levene Test	0.0134	0.909701	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

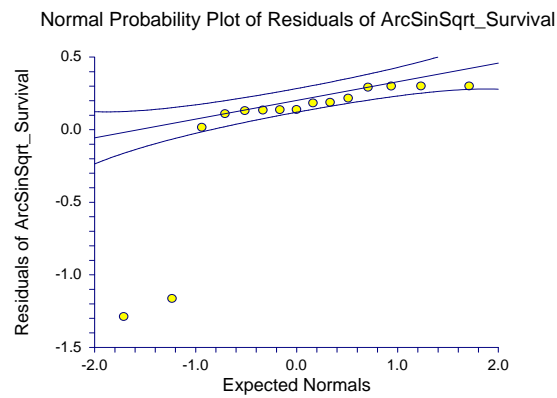
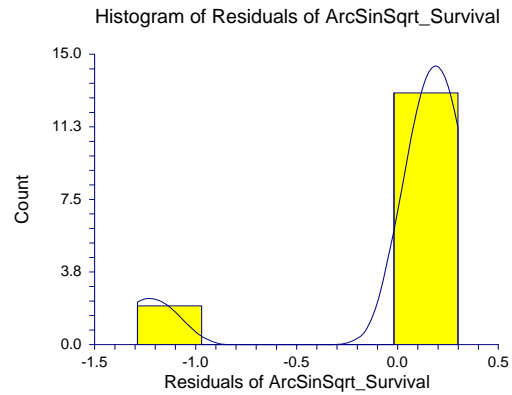
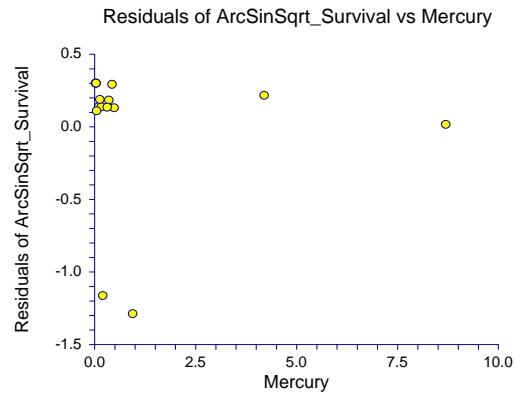
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:39:41 AM

Database

Y = ArcSinSqrt_Survival X = Mercury

Residual Plots Section



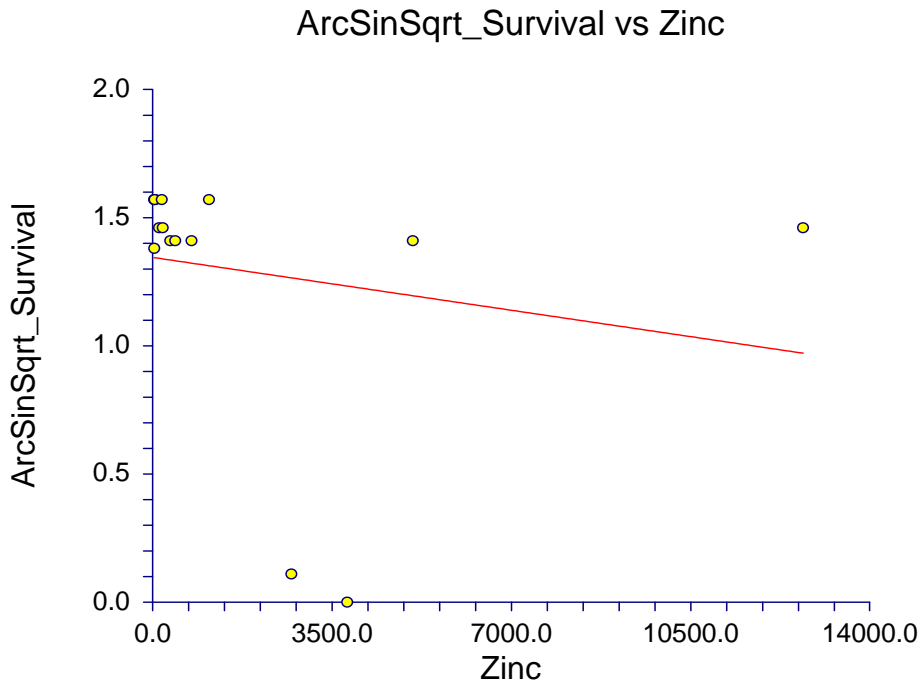
Linear Regression Report

Page/Date/Time 1 8/17/2009 8:40:02 AM

Database

Y = ArcSinSqrt_Survival X = Zinc

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Zinc	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.3448	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	15
R-Squared	0.0385	Sum of Weights	15.0000
Correlation	-0.1963	Coefficient of Variation	0.3998
Mean Square Error	0.2663218	Square Root of MSE	0.5160637

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:40:02 AM

Y = ArcSinSqrt_Survival X = Zinc

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Zinc is estimated as:
 $\text{ArcSinSqrt_Survival} = (1.3448) + (0.0000) \text{ Zinc}$ using the 15 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when Zinc is zero, is 1.3448 with a standard error of 0.1529. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Zinc, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Zinc, is 0.0385. The correlation between ArcSinSqrt_Survival and Zinc is -0.1963.

A significance test that the slope is zero resulted in a t-value of -0.7217. The significance level of this t-test is 0.4833. Since $0.4833 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is -0.0001 and the upper limit is 0.0001. The estimated intercept is 1.3448. The lower limit of the 95% confidence interval for the intercept is 1.0145 and the upper limit is 1.6750.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Zinc
Count	15	15
Mean	1.2907	1838.8667
Standard Deviation	0.5072	3384.3302
Minimum	0.0000	30.0000
Maximum	1.5700	12700.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:40:02 AM

Database

Y = ArcSinSqrt_Survival X = Zinc

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.3448	0.0000
Lower 95% Confidence Limit	1.0145	-0.0001
Upper 95% Confidence Limit	1.6750	0.0001
Standard Error	0.1529	0.0000
Standardized Coefficient	0.0000	-0.1963
T Value	8.7964	-0.7217
Prob Level (T Test)	0.0000	0.4833
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1028
Regression of Y on X	1.3448	0.0000
Inverse Regression from X on Y	2.6947	-0.0008
Orthogonal Regression of Y and X	1.3448	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.34475055572708) + (-2.94115337673977E-05) * (Zinc)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	24.98731	24.98731			
Slope	1	0.1387103	0.1387103	0.5208	0.4833	0.1028
Error	13	3.462183	0.2663218			
Adj. Total	14	3.600893	0.2572067			
Total	15	28.5882				

$s = \text{Square Root}(0.2663218) = 0.5160637$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:40:02 AM

Database

Y = ArcSinSqrt_Survival X = Zinc

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6219	0.000041	No
Anderson Darling	2.6513	0.000001	No
D'Agostino Skewness	-3.2592	0.001117	No
D'Agostino Kurtosis	2.3024	0.021310	No
D'Agostino Omnibus	15.9233	0.000349	No
Constant Residual Variance?			
Modified Levene Test	3.8870	0.070325	No
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

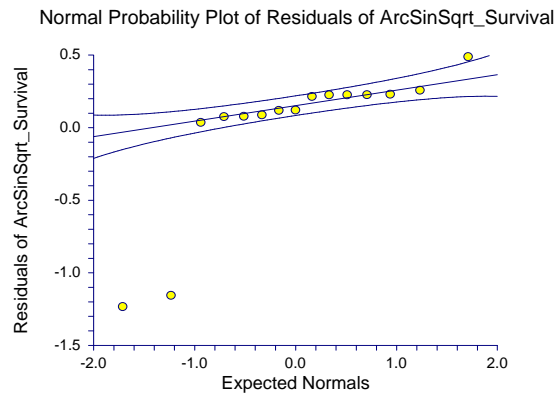
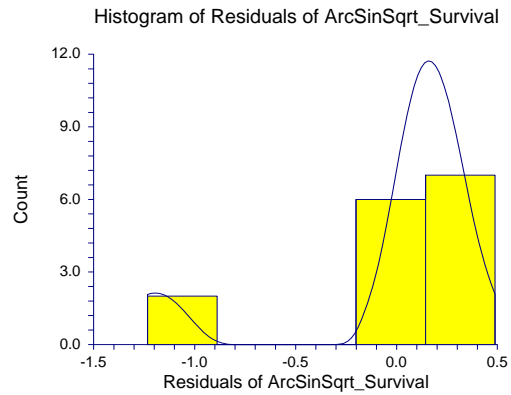
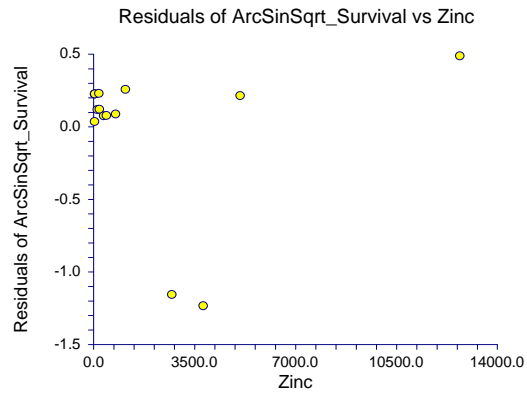
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:40:02 AM

Database

Y = ArcSinSqrt_Survival X = Zinc

Residual Plots Section



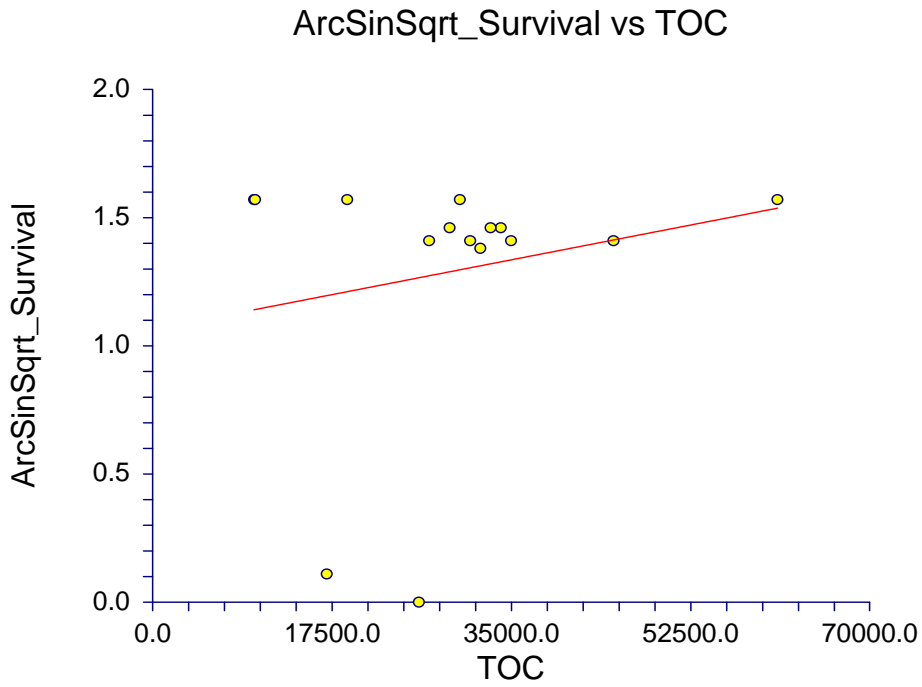
Linear Regression Report

Page/Date/Time 1 8/17/2009 8:42:19 AM

Database

Y = ArcSinSqrt_Survival X = TOC

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	TOC	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.0638	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	15
R-Squared	0.0393	Sum of Weights	15.0000
Correlation	0.1982	Coefficient of Variation	0.3997
Mean Square Error	0.2661152	Square Root of MSE	0.5158635

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:42:19 AM
Y = ArcSinSqrt_Survival X = TOC

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and TOC is estimated as:
 $\text{ArcSinSqrt_Survival} = (1.0638) + (0.0000) \text{ TOC}$ using the 15 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when TOC is zero, is 1.0638 with a standard error of 0.3385. The slope, the estimated change in ArcSinSqrt_Survival per unit change in TOC, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in TOC, is 0.0393. The correlation between ArcSinSqrt_Survival and TOC is 0.1982.

A significance test that the slope is zero resulted in a t-value of 0.7289. The significance level of this t-test is 0.4790. Since $0.4790 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 1.0638. The lower limit of the 95% confidence interval for the intercept is 0.3326 and the upper limit is 1.7951.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	TOC
Count	15	15
Mean	1.2907	29260.0000
Standard Deviation	0.5072	12963.6745
Minimum	0.0000	9900.0000
Maximum	1.5700	61000.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:42:19 AM

Database

Y = ArcSinSqrt_Survival X = TOC

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.0638	0.0000
Lower 95% Confidence Limit	0.3326	0.0000
Upper 95% Confidence Limit	1.7951	0.0000
Standard Error	0.3385	0.0000
Standardized Coefficient	0.0000	0.1982
T Value	3.1429	0.7289
Prob Level (T Test)	0.0078	0.4790
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.8275	0.1038
Regression of Y on X	1.0638	0.0000
Inverse Regression from X on Y	-4.4860	0.0002
Orthogonal Regression of Y and X	1.0638	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.06383661255233) + (7.75222331217839E-06) * (TOC)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	24.98731	24.98731			
Slope	1	0.1413959	0.1413959	0.5313	0.4790	0.1038
Error	13	3.459497	0.2661152			
Adj. Total	14	3.600893	0.2572067			
Total	15	28.5882				

s = Square Root(0.2661152) = 0.5158635

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:42:19 AM

Database

Y = ArcSinSqrt_Survival X = TOC

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6768	0.000142	No
Anderson Darling	2.1295	0.000021	No
D'Agostino Skewness	-3.1464	0.001653	No
D'Agostino Kurtosis	2.2313	0.025660	No
D'Agostino Omnibus	14.8788	0.000588	No

Constant Residual Variance?

Modified Levene Test	3.1496	0.099352	No
----------------------	--------	----------	----

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

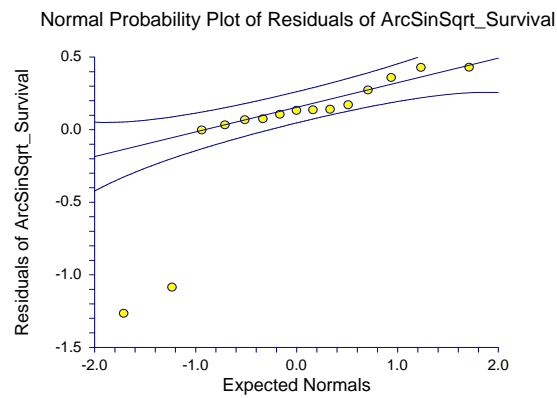
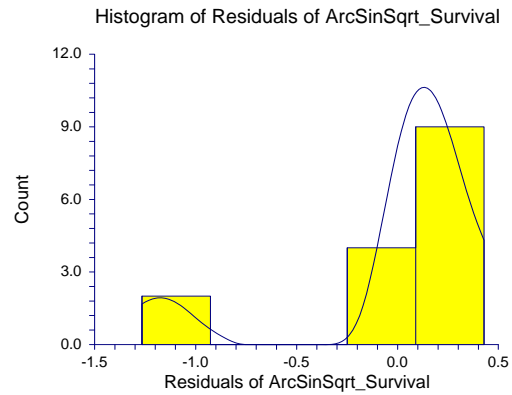
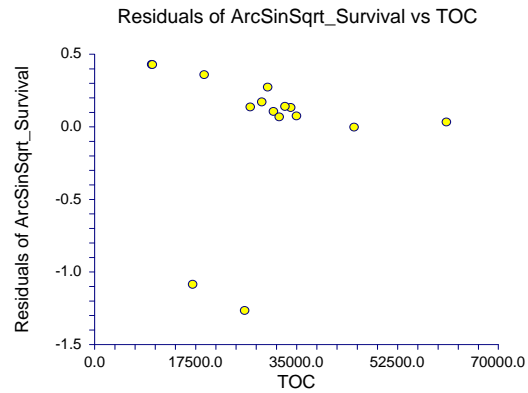
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:42:19 AM

Database

Y = ArcSinSqrt_Survival X = TOC

Residual Plots Section



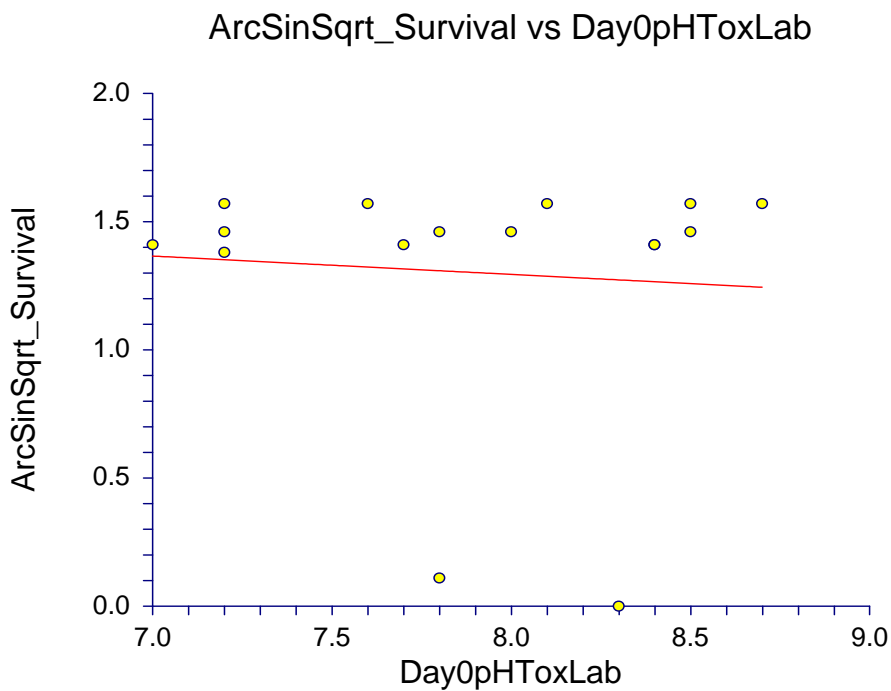
Linear Regression Report

Page/Date/Time 1 8/17/2009 8:50:13 AM

Database

Y = ArcSinSqrt_Survival X = Day0pHToxLab

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Day0pHToxLab	Rows Used in Estimation	16
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.8665	Rows Prediction Only	0
Slope	-0.0716	Sum of Frequencies	16
R-Squared	0.0064	Sum of Weights	16.0000
Correlation	-0.0797	Coefficient of Variation	0.3900
Mean Square Error	0.257481	Square Root of MSE	0.5074258

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:50:13 AM
Y = ArcSinSqrt_Survival X = Day0pHToxLab

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Day0pHToxLab is estimated as: $\text{ArcSinSqrt_Survival} = (1.8665) + (-0.0716) \text{Day0pHToxLab}$ using the 16 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when Day0pHToxLab is zero, is 1.8665 with a standard error of 1.8940. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Day0pHToxLab, is -0.0716 with a standard error of 0.2392. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Day0pHToxLab, is 0.0064. The correlation between ArcSinSqrt_Survival and Day0pHToxLab is -0.0797.

A significance test that the slope is zero resulted in a t-value of -0.2991. The significance level of this t-test is 0.7692. Since $0.7692 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0716. The lower limit of the 95% confidence interval for the slope is -0.5846 and the upper limit is 0.4415. The estimated intercept is 1.8665. The lower limit of the 95% confidence interval for the intercept is -2.1956 and the upper limit is 5.9287.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Day0pHToxLab
Count	16	16
Mean	1.3013	7.9000
Standard Deviation	0.4918	0.5477
Minimum	0.0000	7.0000
Maximum	1.5700	8.7000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:50:13 AM
 Database
 Y = ArcSinSqrt_Survival X = Day0pHToxLab

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.8665	-0.0716
Lower 95% Confidence Limit	-2.1956	-0.5846
Upper 95% Confidence Limit	5.9287	0.4415
Standard Error	1.8940	0.2392
Standardized Coefficient	0.0000	-0.0797
T Value	0.9855	-0.2991
Prob Level (T Test)	0.3411	0.7692
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.1510	0.0590
Regression of Y on X	1.8665	-0.0716
Inverse Regression from X on Y	90.3057	-11.2664
Orthogonal Regression of Y and X	3.9017	-0.3292

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(1.86653888888887) + (-7.1555555555473E-02) * (\text{Day0pHToxLab})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	27.09203	27.09203			
Slope	1	2.304089E-02	2.304089E-02	0.0895	0.7692	0.0590
Error	14	3.604734	0.257481			
Lack of Fit	9	2.669234	0.2965816	1.5852	0.3183	
Pure Error	5	0.9355	0.1871			
Adj. Total	15	3.627775	0.2418517			
Total	16	30.7198				

$s = \text{Square Root}(0.257481) = 0.5074258$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:50:13 AM

Database

Y = ArcSinSqrt_Survival X = Day0pHToxLab

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.5735	0.000009	No
Anderson Darling	3.0637	0.000000	No
D'Agostino Skewness	-3.5313	0.000414	No
D'Agostino Kurtosis	2.5615	0.010423	No
D'Agostino Omnibus	19.0311	0.000074	No

Constant Residual Variance?

Modified Levene Test	0.0096	0.923347	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(9, 5) Test	1.5852	0.318255	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

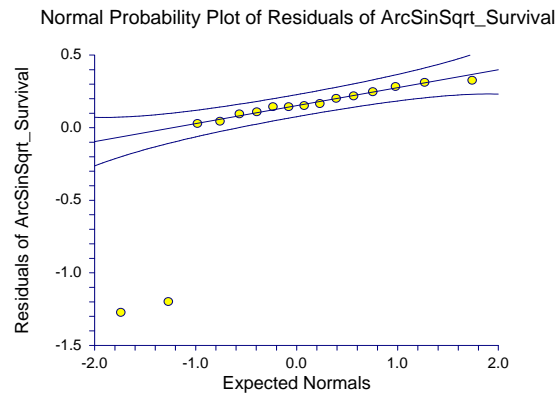
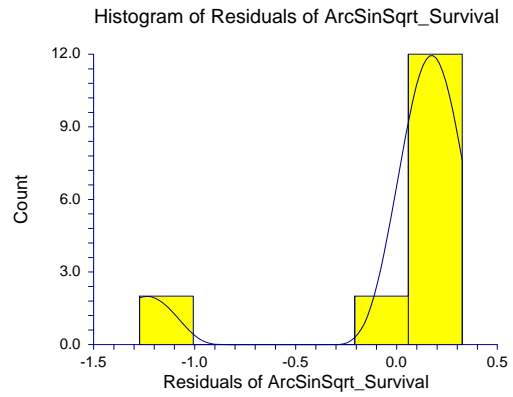
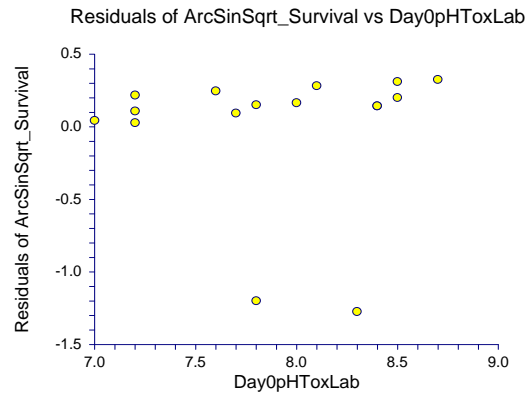
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 8:50:13 AM
Database
Y = ArcSinSqrt_Survival X = Day0pHToxLab

Residual Plots Section



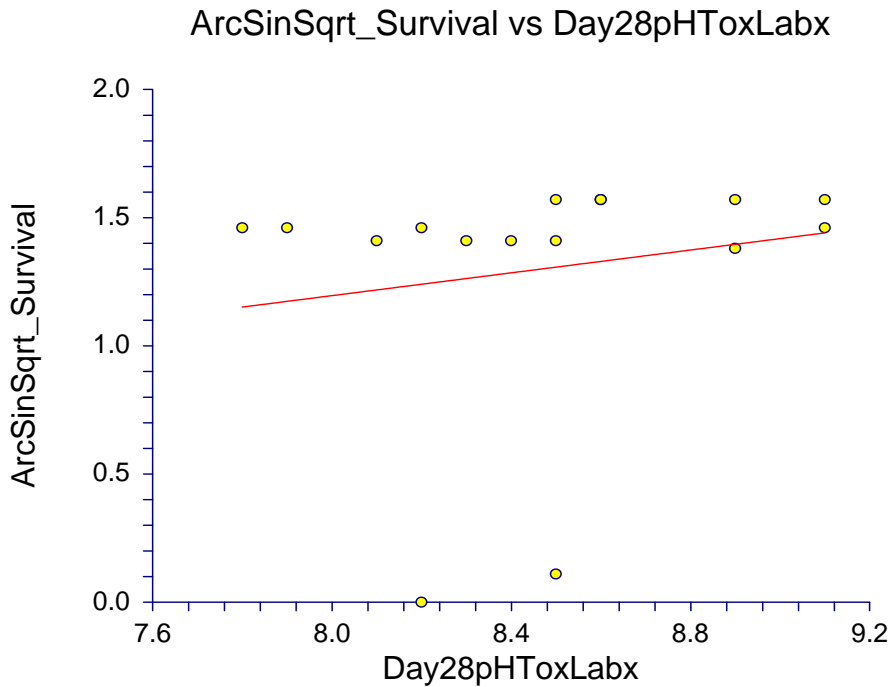
Linear Regression Report

Page/Date/Time 1 8/17/2009 8:50:42 AM

Database

Y = ArcSinSqrt_Survival X = Day28pHToxLabx

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Day28pHToxLabx	Rows Used in Estimation	16
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	-0.5843	Rows Prediction Only	0
Slope	0.2225	Sum of Frequencies	16
R-Squared	0.0312	Sum of Weights	16.0000
Correlation	0.1768	Coefficient of Variation	0.3850
Mean Square Error	0.2510298	Square Root of MSE	0.5010287

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:50:42 AM
Y = ArcSinSqrt_Survival X = Day28pHToxLabx

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Day28pHToxLabx is estimated as: $\text{ArcSinSqrt_Survival} = (-0.5843) + (0.2225) \text{Day28pHToxLabx}$ using the 16 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when Day28pHToxLabx is zero, is -0.5843 with a standard error of 2.8088. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Day28pHToxLabx, is 0.2225 with a standard error of 0.3311. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Day28pHToxLabx, is 0.0312. The correlation between ArcSinSqrt_Survival and Day28pHToxLabx is 0.1768.

A significance test that the slope is zero resulted in a t-value of 0.6720. The significance level of this t-test is 0.5125. Since $0.5125 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.2225. The lower limit of the 95% confidence interval for the slope is -0.4876 and the upper limit is 0.9326. The estimated intercept is -0.5843. The lower limit of the 95% confidence interval for the intercept is -6.6086 and the upper limit is 5.4399.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Day28pHToxLabx
Count	16	16
Mean	1.3013	8.4750
Standard Deviation	0.4918	0.3907
Minimum	0.0000	7.8000
Maximum	1.5700	9.1000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:50:42 AM

Database

Y = ArcSinSqrt_Survival X = Day28pHToxLabx

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-0.5843	0.2225
Lower 95% Confidence Limit	-6.6086	-0.4876
Upper 95% Confidence Limit	5.4399	0.9326
Standard Error	2.8088	0.3311
Standardized Coefficient	0.0000	0.1768
T Value	-0.2080	0.6720
Prob Level (T Test)	0.8382	0.5125
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.0543	0.0961
Regression of Y on X	-0.5843	0.2225
Inverse Regression from X on Y	-59.0430	7.1203
Orthogonal Regression of Y and X	-23.8114	2.9631

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(-.584344978165864) + (.222489082969424) * (\text{Day28pHToxLabx})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	27.09203	27.09203			
Slope	1	0.1133582	0.1133582	0.4516	0.5125	0.0961
Error	14	3.514417	0.2510298			
Lack of Fit	8	1.142117	0.1427646	0.3611	0.9079	
Pure Error	6	2.3723	0.3953833			
Adj. Total	15	3.627775	0.2418517			
Total	16	30.7198				

$s = \text{Square Root}(0.2510298) = 0.5010287$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:50:42 AM

Database

Y = ArcSinSqrt_Survival X = Day28pHToxLabx

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.5727	0.000009	No
Anderson Darling	3.0426	0.000000	No
D'Agostino Skewness	-3.5186	0.000434	No
D'Agostino Kurtosis	2.5401	0.011083	No
D'Agostino Omnibus	18.8327	0.000081	No

Constant Residual Variance?

Modified Levene Test	0.0036	0.953011	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(8, 6) Test	0.3611	0.907906	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

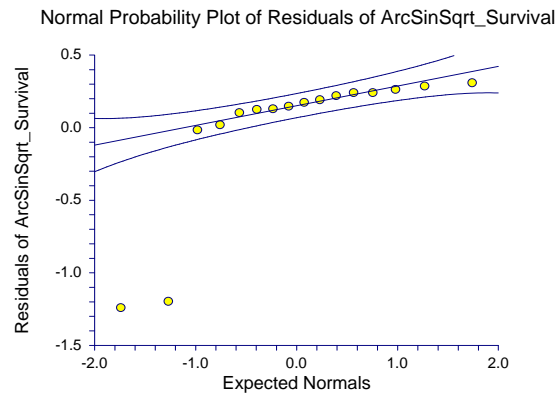
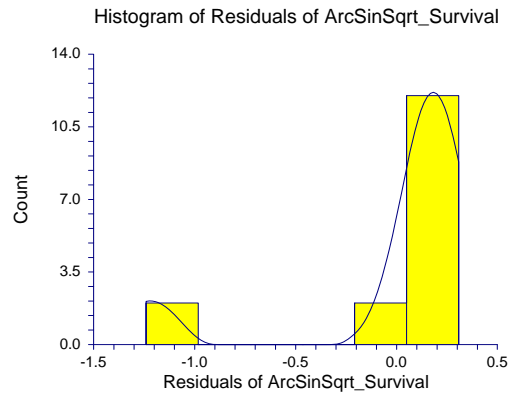
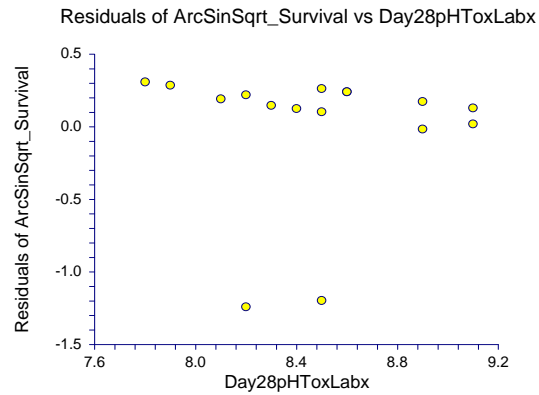
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:50:42 AM

Database

Y = ArcSinSqrt_Survival X = Day28pHToxLabx

Residual Plots Section



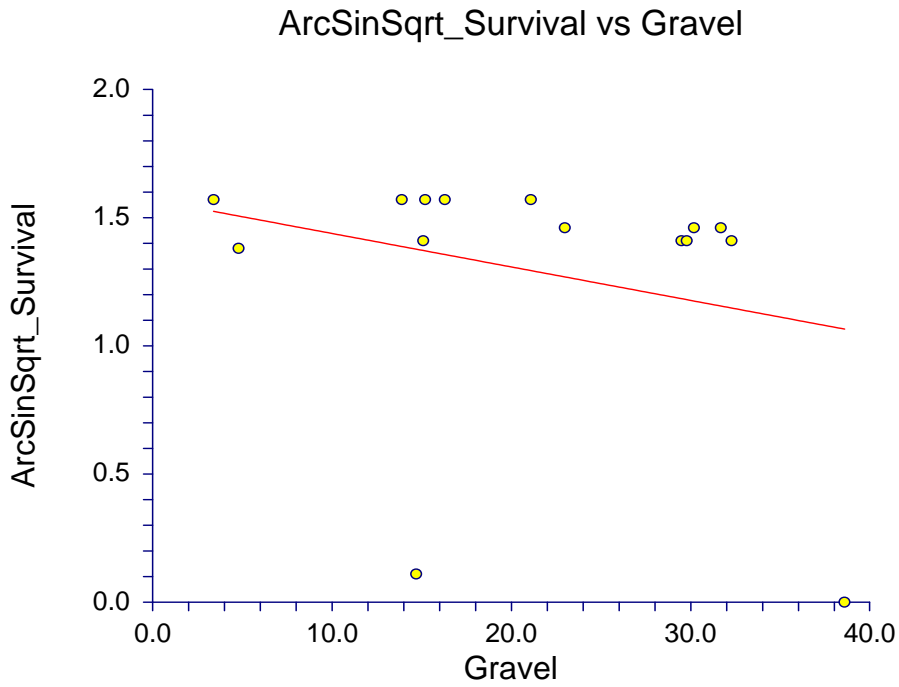
Linear Regression Report

Page/Date/Time 1 8/17/2009 8:42:34 AM

Database

Y = ArcSinSqrt_Survival X = Gravel

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Gravel	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.5686	Rows Prediction Only	0
Slope	-0.0130	Sum of Frequencies	15
R-Squared	0.0729	Sum of Weights	15.0000
Correlation	-0.2699	Coefficient of Variation	0.3926
Mean Square Error	0.2568097	Square Root of MSE	0.5067639

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:42:34 AM

Y = ArcSinSqrt_Survival X = Gravel

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Gravel is estimated as:
 $\text{ArcSinSqrt_Survival} = (1.5686) + (-0.0130) \text{ Gravel}$ using the 15 observations in this dataset.
The y-intercept, the estimated value of ArcSinSqrt_Survival when Gravel is zero, is 1.5686 with a standard error of 0.3045. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Gravel, is -0.0130 with a standard error of 0.0129. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Gravel, is 0.0729. The correlation between ArcSinSqrt_Survival and Gravel is -0.2699.

A significance test that the slope is zero resulted in a t-value of -1.0108. The significance level of this t-test is 0.3306. Since $0.3306 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0130. The lower limit of the 95% confidence interval for the slope is -0.0409 and the upper limit is 0.0148. The estimated intercept is 1.5686. The lower limit of the 95% confidence interval for the intercept is 0.9107 and the upper limit is 2.2265.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Gravel
Count	15	15
Mean	1.2907	21.3067
Standard Deviation	0.5072	10.4939
Minimum	0.0000	3.4000
Maximum	1.5700	38.6000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:42:34 AM

Database

Y = ArcSinSqrt_Survival X = Gravel

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.5686	-0.0130
Lower 95% Confidence Limit	0.9107	-0.0409
Upper 95% Confidence Limit	2.2265	0.0148
Standard Error	0.3045	0.0129
Standardized Coefficient	0.0000	-0.2699
T Value	5.1509	-1.0108
Prob Level (T Test)	0.0002	0.3306
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9973	0.1552
Regression of Y on X	1.5686	-0.0130
Inverse Regression from X on Y	5.1054	-0.1790
Orthogonal Regression of Y and X	1.5692	-0.0131

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.56861860687964) + (-.013045303827267) * (Gravel)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	24.98731	24.98731			
Slope	1	0.262368	0.262368	1.0216	0.3306	0.1552
Error	13	3.338525	0.2568097			
Adj. Total	14	3.600893	0.2572067			
Total	15	28.5882				

s = Square Root(0.2568097) = 0.5067639

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:42:34 AM

Database

Y = ArcSinSqrt_Survival X = Gravel

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6112	0.000032	No
Anderson Darling	2.5981	0.000001	No
D'Agostino Skewness	-3.2974	0.000976	No
D'Agostino Kurtosis	2.3198	0.020354	No
D'Agostino Omnibus	16.2545	0.000295	No
Constant Residual Variance?			
Modified Levene Test	0.0592	0.811638	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

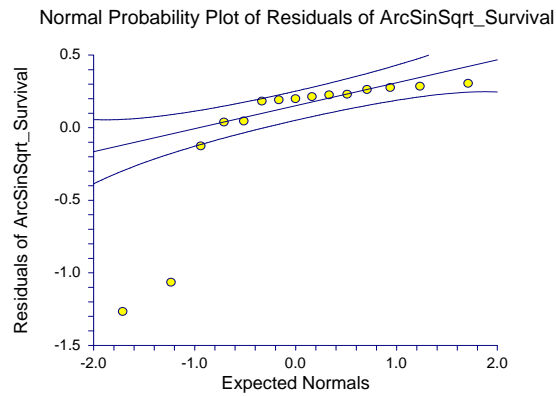
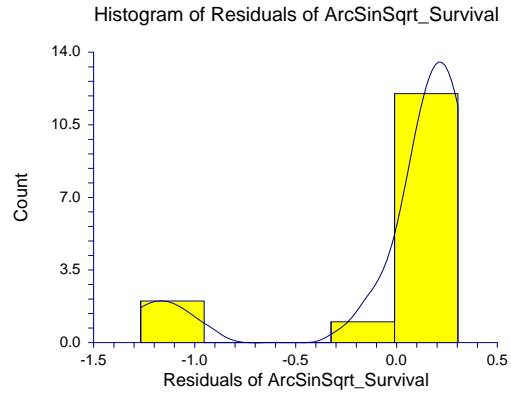
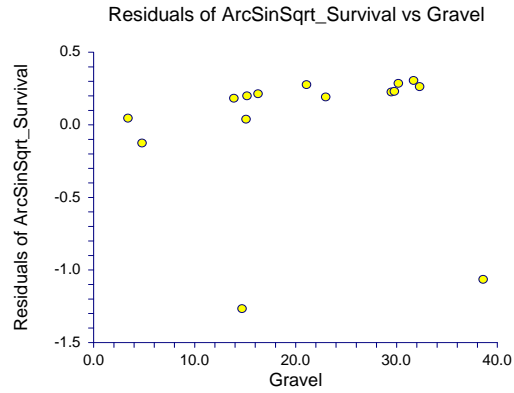
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:42:34 AM

Database

Y = ArcSinSqrt_Survival X = Gravel

Residual Plots Section



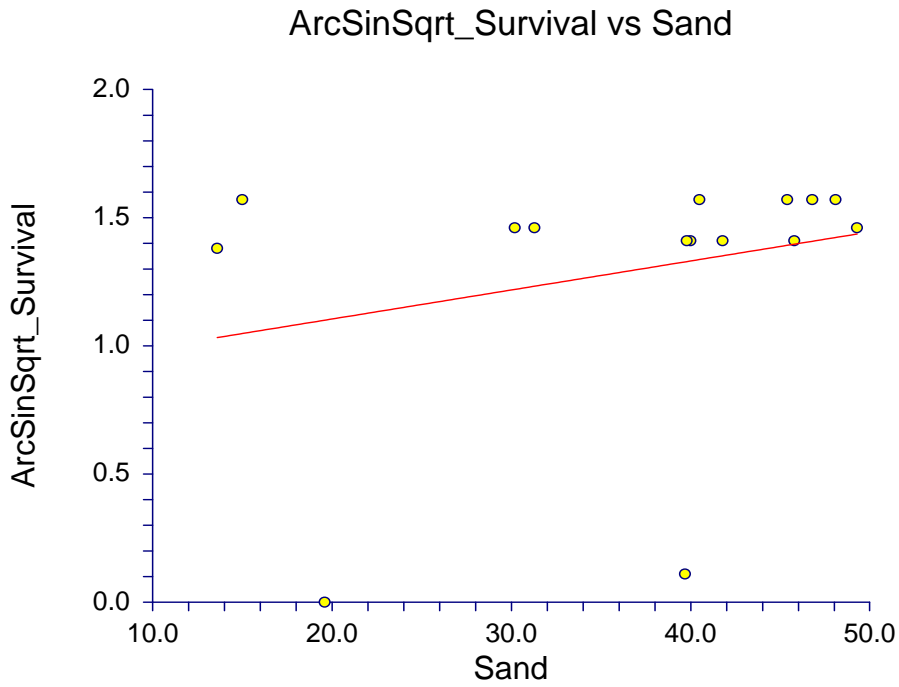
Linear Regression Report

Page/Date/Time 1 8/17/2009 8:42:49 AM

Database

Y = ArcSinSqrt_Survival X = Sand

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Sand	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.8781	Rows Prediction Only	0
Slope	0.0113	Sum of Frequencies	15
R-Squared	0.0706	Sum of Weights	15.0000
Correlation	0.2658	Coefficient of Variation	0.3931
Mean Square Error	0.257429	Square Root of MSE	0.5073746

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:42:49 AM

Y = ArcSinSqrt_Survival X = Sand

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Sand is estimated as:
 $\text{ArcSinSqrt_Survival} = (0.8781) + (0.0113) \text{ Sand}$ using the 15 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when Sand is zero, is 0.8781 with a standard error of 0.4352. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Sand, is 0.0113 with a standard error of 0.0114. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Sand, is 0.0706. The correlation between ArcSinSqrt_Survival and Sand is 0.2658.

A significance test that the slope is zero resulted in a t-value of 0.9939. The significance level of this t-test is 0.3384. Since $0.3384 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0113. The lower limit of the 95% confidence interval for the slope is -0.0133 and the upper limit is 0.0359. The estimated intercept is 0.8781. The lower limit of the 95% confidence interval for the intercept is -0.0621 and the upper limit is 1.8184.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Sand
Count	15	15
Mean	1.2907	36.4600
Standard Deviation	0.5072	11.9123
Minimum	0.0000	13.6000
Maximum	1.5700	49.3000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:42:49 AM

Database

Y = ArcSinSqrt_Survival X = Sand

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.8781	0.0113
Lower 95% Confidence Limit	-0.0621	-0.0133
Upper 95% Confidence Limit	1.8184	0.0359
Standard Error	0.4352	0.0114
Standardized Coefficient	0.0000	0.2658
T Value	2.0177	0.9939
Prob Level (T Test)	0.0648	0.3384
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.4635	0.1516
Regression of Y on X	0.8781	0.0113
Inverse Regression from X on Y	-4.5502	0.1602
Orthogonal Regression of Y and X	0.8775	0.0113

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.878147209654916) + (1.13143021670804E-02) * (Sand)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	24.98731	24.98731			
Slope	1	0.2543161	0.2543161	0.9879	0.3384	0.1516
Error	13	3.346577	0.257429			
Adj. Total	14	3.600893	0.2572067			
Total	15	28.5882				

s = Square Root(0.257429) = 0.5073746

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:42:49 AM

Database

Y = ArcSinSqrt_Survival X = Sand

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.6775	0.000144	No
Anderson Darling	2.2081	0.000013	No
D'Agostino Skewness	-3.1301	0.001747	No
D'Agostino Kurtosis	2.2140	0.026828	No
D'Agostino Omnibus	14.6996	0.000643	No
Constant Residual Variance?			
Modified Levene Test	3.0768	0.102944	No
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

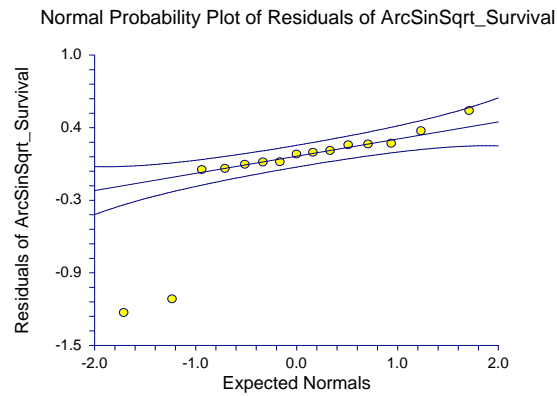
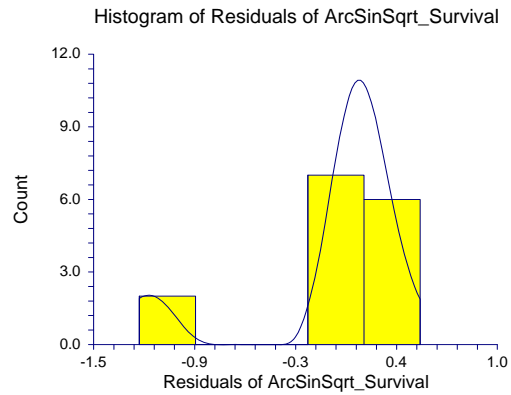
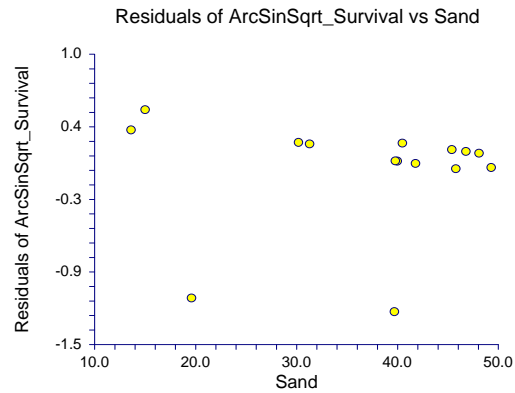
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:42:49 AM

Database

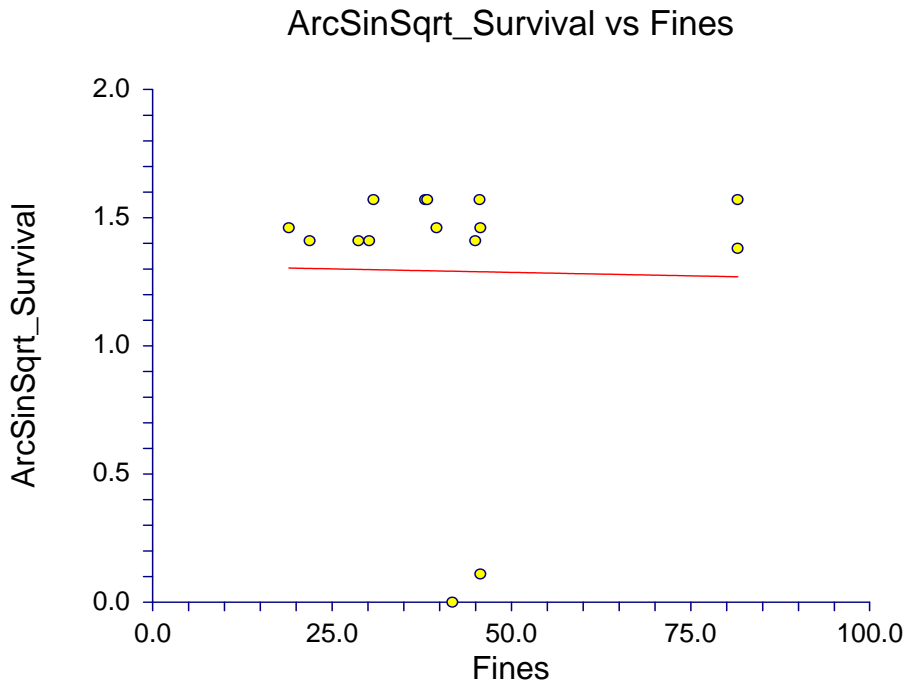
Y = ArcSinSqrt_Survival X = Sand

Residual Plots Section



Page/Date/Time 1 8/17/2009 8:43:06 AM
Database
Y = ArcSinSqrt_Survival X = Fines

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Independent Variable	Fines	Rows Used in Estimation	15
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.3136	Rows Prediction Only	0
Slope	-0.0005	Sum of Frequencies	15
R-Squared	0.0004	Sum of Weights	15.0000
Correlation	-0.0194	Coefficient of Variation	0.4077
Mean Square Error	0.2768876	Square Root of MSE	0.5262011

Linear Regression Report

Page/Date/Time 2 8/17/2009 8:43:06 AM

Y = ArcSinSqrt_Survival X = Fines

Summary Statement

The equation of the straight line relating ArcSinSqrt_Survival and Fines is estimated as:
 $\text{ArcSinSqrt_Survival} = (1.3136) + (-0.0005) \text{ Fines}$ using the 15 observations in this dataset. The y-intercept, the estimated value of ArcSinSqrt_Survival when Fines is zero, is 1.3136 with a standard error of 0.3549. The slope, the estimated change in ArcSinSqrt_Survival per unit change in Fines, is -0.0005 with a standard error of 0.0078. The value of R-Squared, the proportion of the variation in ArcSinSqrt_Survival that can be accounted for by variation in Fines, is 0.0004. The correlation between ArcSinSqrt_Survival and Fines is -0.0194.

A significance test that the slope is zero resulted in a t-value of -0.0700. The significance level of this t-test is 0.9453. Since $0.9453 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0005. The lower limit of the 95% confidence interval for the slope is -0.0173 and the upper limit is 0.0162. The estimated intercept is 1.3136. The lower limit of the 95% confidence interval for the intercept is 0.5469 and the upper limit is 2.0803.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	ArcSinSqrt_Survival	Fines
Count	15	15
Mean	1.2907	42.2333
Standard Deviation	0.5072	18.1165
Minimum	0.0000	19.0000
Maximum	1.5700	81.6000

Linear Regression Report

Page/Date/Time 3 8/17/2009 8:43:06 AM

Database

Y = ArcSinSqrt_Survival X = Fines

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.3136	-0.0005
Lower 95% Confidence Limit	0.5469	-0.0173
Upper 95% Confidence Limit	2.0803	0.0162
Standard Error	0.3549	0.0078
Standardized Coefficient	0.0000	-0.0194
T Value	3.7015	-0.0700
Prob Level (T Test)	0.0027	0.9453
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9274	0.0505
Regression of Y on X	1.3136	-0.0005
Inverse Regression from X on Y	62.2355	-1.4431
Orthogonal Regression of Y and X	1.3136	-0.0005

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.31360208172225) + (-5.43064287030449E-04) * (Fines)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	24.98731	24.98731			
Slope	1	1.355126E-03	1.355126E-03	0.0049	0.9453	0.0505
Error	13	3.599538	0.2768876			
Lack of Fit	11	2.670238	0.2427489	0.5224	0.8065	
Pure Error	2	0.9293	0.46465			
Adj. Total	14	3.600893	0.2572067			
Total	15	28.5882				

s = Square Root(0.2768876) = 0.5262011

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 8:43:06 AM

Database

Y = ArcSinSqrt_Survival X = Fines

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.5485	0.000009	No
Anderson Darling	3.1517	0.000000	No
D'Agostino Skewness	-3.4256	0.000613	No
D'Agostino Kurtosis	2.4322	0.015009	No
D'Agostino Omnibus	17.6501	0.000147	No

Constant Residual Variance?

Modified Levene Test	2.9740	0.108290	No
----------------------	--------	----------	----

Relationship is a Straight Line?

Lack of Linear Fit F(11, 2) Test	0.5224	0.806506	Yes
----------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

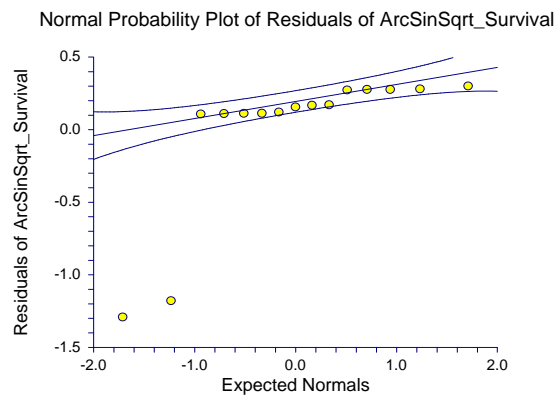
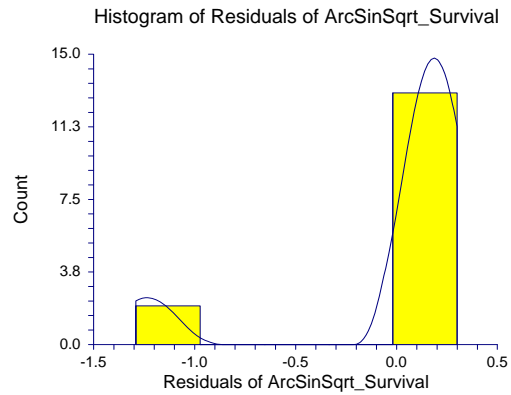
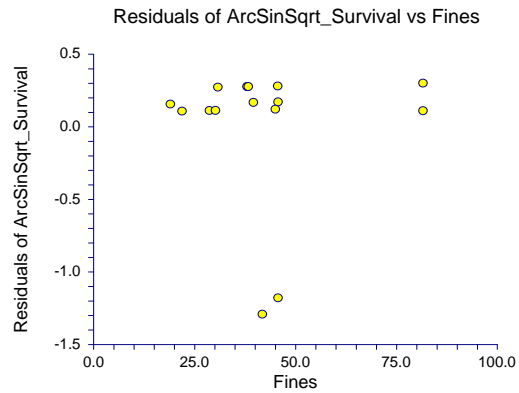
Linear Regression Report

Page/Date/Time 5 8/17/2009 8:43:06 AM

Database

Y = ArcSinSqrt_Survival X = Fines

Residual Plots Section



**ALL POSSIBLE REGRESSION AND MULTIPLE REGRESSION
REPORTS**

All Possible Regression Report

Page/Date/Time 1 9/11/2009 11:11:45 AM

Database

Dependent Mean_Growth

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
1	0.270612	6.482833E-02	0.040112	B (Copper)
1	0.136378	7.054193E-02	1.887857	H (TOC)
1	0.120072	7.120477E-02	2.112310	I (Gravel)
1	0.096456	7.215399E-02	2.437399	K (Fines)
1	0.046674	7.411503E-02	3.122647	J (Sand)
1	0.031923	7.468624E-02	3.325699	D (Mercury)
1	0.029778	7.476894E-02	3.355229	G (pH28)
1	0.018107	0.0752173	3.515881	F (pH0)
1	0.006858	7.564694E-02	3.670725	A (Antimony)
1	0.006615	7.565618E-02	3.674066	C (Lead)
1	0.000522	7.588784E-02	3.757935	E (Zinc)
2	0.543454	5.357008E-02	-1.715584	BI
2	0.510039	5.549588E-02	-1.255624	BH
2	0.500166	5.605223E-02	-1.119719	BK
2	0.418106	6.047861E-02	0.009841	BG
2	0.386555	0.0620966	0.444150	BJ
2	0.308148	6.594569E-02	1.523426	BE
2	0.281262	6.721483E-02	1.893513	BD
2	0.278181	6.735873E-02	1.935921	AB
2	0.274848	6.751409E-02	1.981807	BF
2	0.274072	0.0675502	1.992485	BC
3	0.640871	4.983125E-02	-1.056539	BHI
3	0.622564	5.108555E-02	-0.804542	BHK
3	0.575474	5.417866E-02	-0.156350	BCI
3	0.569063	5.458625E-02	-0.068096	BGI
3	0.567591	5.467937E-02	-0.047839	BHJ
3	0.563412	5.494294E-02	0.009680	ABI
3	0.556962	5.534734E-02	0.098474	BGH
3	0.555803	5.541966E-02	0.114421	BFI
3	0.553393	5.556981E-02	0.147597	BDI
3	0.548155	5.589472E-02	0.219697	BJK
4	0.702484	4.780901E-02	0.095337	BIJK
4	0.688390	4.892835E-02	0.289347	BDHI
4	0.676444	4.985742E-02	0.453789	BCHI
4	0.648596	5.195869E-02	0.837117	BGHI
4	0.646319	0.0521268	0.868466	ABHI
4	0.645144	0.0522133	0.884637	BCHK
4	0.644844	5.223535E-02	0.888765	BHJK
4	0.644149	5.228643E-02	0.898330	BHIK
4	0.644015	5.229628E-02	0.900176	BHIJ
4	0.642535	5.240484E-02	0.920542	BEHI

All Possible Regression Report

Page/Date/Time 2 9/11/2009 11:11:45 AM

Database

Dependent Mean_Growth

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
5	0.745575	4.689329E-02	1.502185	BCDHI
5	0.739011	4.749441E-02	1.592548	BHIJK
5	0.718145	4.935644E-02	1.879764	BGIJK
5	0.716481	4.950193E-02	1.902670	BCIJK
5	0.708274	0.0502133	2.015644	ABIIK
5	0.707654	5.026662E-02	2.024177	BFIJK
5	0.705624	5.044083E-02	2.052118	BDIJK
5	0.705228	5.047473E-02	2.057566	BDGHI
5	0.702577	5.070127E-02	2.094070	BEIJK
5	0.692864	5.152248E-02	2.227768	BDFHI
6	0.765677	0.0481099	3.225481	BCDghi
6	0.764208	4.826045E-02	3.245700	BCDFHI
6	0.760288	4.865997E-02	3.299661	BCDEHI
6	0.760287	4.866008E-02	3.299676	BDHIJK
6	0.757476	4.894454E-02	3.338368	BCHijk
6	0.752863	4.940786E-02	3.401871	BFHIJK
6	0.747515	4.993955E-02	3.475481	BCDHIJK
6	0.747383	4.995263E-02	3.477302	ABHIJK
6	0.746577	5.003231E-02	3.488404	BCDHIJ
6	0.746525	5.003744E-02	3.489120	BCDHIK
7	0.802107	4.775469E-02	4.724024	BCDFGHI
7	0.793531	0.0487784	4.842065	BCDHIJK
7	0.783770	4.991819E-02	4.976436	BDFHIJK
7	0.780097	5.034038E-02	5.026996	ABCDFHI
7	0.780056	0.050345	5.027552	BCDEGHI
7	0.776192	5.078533E-02	5.080743	BCFHIJK
7	0.773163	5.112788E-02	5.122443	BCDEFHI
7	0.771142	5.135511E-02	5.150259	BCDGHJK
7	0.770363	5.144249E-02	5.160987	ABDHIJK
7	0.770186	5.146223E-02	5.163415	BCDGHIJ
8	0.831326	4.829651E-02	6.321823	BCDFHIJK
8	0.826459	4.898827E-02	6.388812	ABCDFGHI
8	0.808331	5.148335E-02	6.638343	BCDEFGHI
8	0.804705	5.196811E-02	6.688261	BCDFGHJK
8	0.803604	5.211438E-02	6.703415	BCDFGHIJ
8	0.803543	5.212241E-02	6.704249	BCDFGHIK
8	0.801193	5.243327E-02	6.736601	BCDGHJK
8	0.800029	5.258654E-02	6.752623	BCDEHIJK
8	0.798551	5.278049E-02	6.772965	ABCDHIJK
8	0.791339	5.371703E-02	6.872246	BDFGHIJK

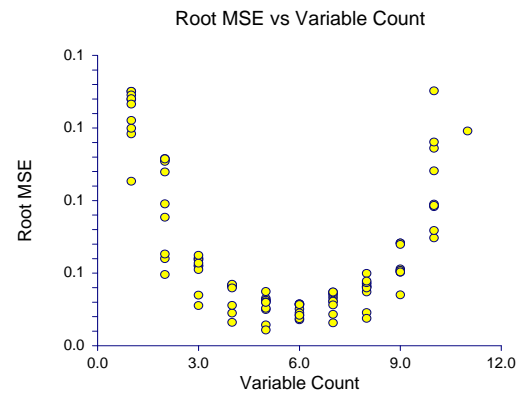
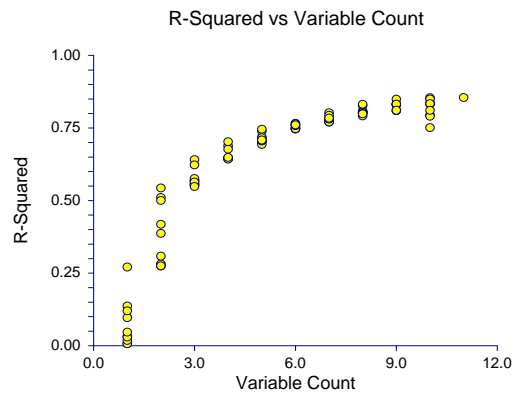
All Possible Regression Report

Page/Date/Time 3 9/11/2009 11:11:45 AM
 Database
 Dependent Mean_Growth

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
9	0.848765	5.112965E-02	8.081772	BCDFGHIJK
9	0.832255	5.384823E-02	8.309034	BCDEFHIJK
9	0.831993	5.389027E-02	8.312642	ABCDFHIJK
9	0.831692	5.393854E-02	8.316786	ABCDFGHJK
9	0.830951	5.405699E-02	8.326973	ABCDFGHIJ
9	0.830884	5.406779E-02	8.327903	ABCDFGHIK
9	0.829734	5.425125E-02	8.343728	ABCDEFGHI
9	0.810720	5.720041E-02	8.605468	BCDEFGHJK
9	0.809634	5.736423E-02	8.620414	BCDEFGHIJ
9	0.809582	0.057372	8.621125	BCDEFGHIK
10	0.854090	5.799067E-02	10.008469	ABCDFGHIJK
10	0.849549	5.888614E-02	10.070976	BCDEFGHIJK
10	0.834519	6.175753E-02	10.277869	ABCDEFGHJK
10	0.833795	6.189249E-02	10.287835	ABCDEFGHIJ
10	0.833735	6.190367E-02	10.288662	ABCDEFGHIK
10	0.832868	6.206489E-02	10.300598	ABCDEFHIJK
10	0.810528	6.608282E-02	10.608111	ABCDEGHIJK
10	0.794587	0.0688066	10.827542	ABDEFGHIJK
10	0.790149	6.954591E-02	10.888631	ABCEFGHIJK
10	0.751260	0.0757162	11.423943	ABCDEFGIJK
11	0.854705	7.087388E-02	12.000000	ABCDEFGHIJK

Plots Section

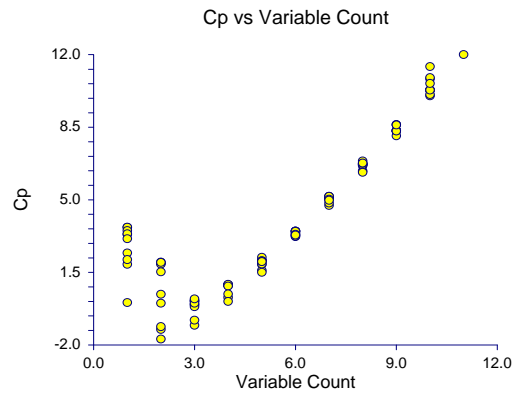


All Possible Regression Report

Page/Date/Time 4 9/11/2009 11:11:45 AM

Database

Dependent Mean_Growth



Multiple Regression Report

Page/Date/Time 1 9/11/2009 11:36:13 AM

Database

Dependent Mean_Growth

Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	16
Number Ind. Variables	5	Rows Filtered Out	0
Weight Variable	None	Rows with X's Missing	1
R2	0.7456	Rows with Weight Missing	0
Adj R2	0.5866	Rows with Y Missing	1
Coefficient of Variation	0.3671	Rows Used in Estimation	14
Mean Square Error	2.198981E-03	Sum of Weights	14.000
Square Root of MSE	4.689329E-02	Completion Status	Normal Completion
Ave Abs Pct Error	19.655		

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Minimum	Maximum
Copper	14	2102.079	5386.613	41	19300
Gravel	14	20.07143	9.692537	3.4	32.3
Lead	14	523.6572	911.1542	2.1	3550
Mercury	14	1.086643	2.44216	0.024	8.7
TOC	14	29492.86	13420.45	9900	61000
Mean_Growth	14	0.1277286	7.292972E-02	0.0599	0.3446

Regression Equation Section

Independent Variable	Regression Coefficient b(i)	Standard Error Sb(i)	T-Value to test H0:B(i)=0	Prob Level	Reject H0 at 5%?	Power of Test at 5%
Intercept	0.2473	0.0378	6.536	0.0002	Yes	0.9999
Copper	0.0000	0.0000	4.200	0.0030	Yes	0.9554
Gravel	-0.0046	0.0017	-2.624	0.0305	Yes	0.6341
Lead	0.0000	0.0000	1.341	0.2168	No	0.2197
Mercury	0.0093	0.0063	1.474	0.1786	No	0.2555
TOC	0.0000	0.0000	-2.185	0.0604	No	0.4848

Estimated Model

.247302402067372+ 1.15374917624218E-05*Copper-4.5504947337764E-03*Gravel+ 2.16257552601163E-05*Lead+ 9.29965169178805E-03*Mercury-2.50642030934284E-06*TOC

Multiple Regression Report

Page/Date/Time 2 9/11/2009 11:36:13 AM

Database

Dependent Mean_Growth

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	0.2473	0.0378	0.1600	0.3346	0.0000
Copper	0.0000	0.0000	0.0000	0.0000	0.8522
Gravel	-0.0046	0.0017	-0.0086	-0.0006	-0.6048
Lead	0.0000	0.0000	0.0000	0.0001	0.2702
Mercury	0.0093	0.0063	-0.0052	0.0238	0.3114
TOC	0.0000	0.0000	0.0000	0.0000	-0.4612

Note: The T-Value used to calculate these confidence limits was 2.306.

Analysis of Variance Section

Source	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		0.2284042	0.2284042			
Model	5	0.7456	5.155182E-02	1.031036E-02	4.689	0.0269	0.7781
Error	8	0.2544	1.759185E-02	2.198981E-03			
Total(Adjusted)	13	1.0000	6.914367E-02	5.318744E-03			

Analysis of Variance Detail Section

Model Term	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		0.2284042	0.2284042			
Model	5	0.7456	5.155182E-02	1.031036E-02	4.689	0.0269	0.7781
Copper	1	0.5610	3.879291E-02	3.879291E-02	17.641	0.0030	0.9554
Gravel	1	0.2189	1.513573E-02	1.513573E-02	6.883	0.0305	0.6341
Lead	1	0.0572	3.953998E-03	3.953998E-03	1.798	0.2168	0.2197
Mercury	1	0.0691	4.780006E-03	4.780006E-03	2.174	0.1786	0.2555
TOC	1	0.1518	1.049822E-02	1.049822E-02	4.774	0.0604	0.4848
Error	8	0.2544	1.759185E-02	2.198981E-03			
Total(Adjusted)	13	1.0000	6.914367E-02	5.318744E-03			

Normality Tests Section

Test Name	Test Value	Prob Level	Reject H0 At Alpha = 20%?
Shapiro Wilk	0.8796	0.057282	Yes
Anderson Darling	0.5192	0.187141	Yes
D'Agostino Skewness	2.2358	0.025366	Yes
D'Agostino Kurtosis	1.9089	0.056269	Yes
D'Agostino Omnibus	8.6428	0.013281	Yes

Multiple Regression Report

Page/Date/Time 3 9/11/2009 11:36:13 AM
 Database
 Dependent Mean_Growth

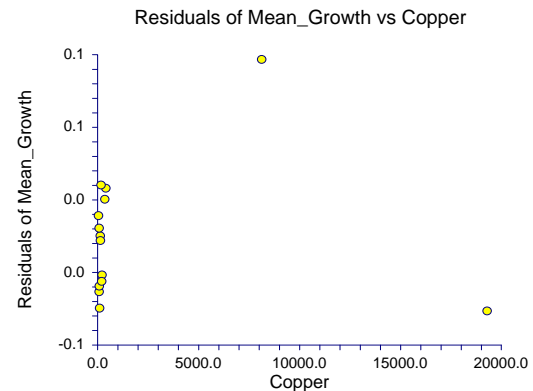
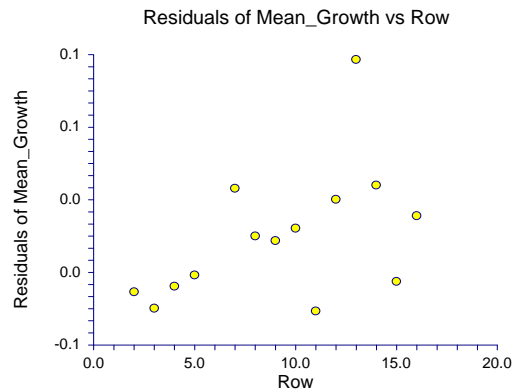
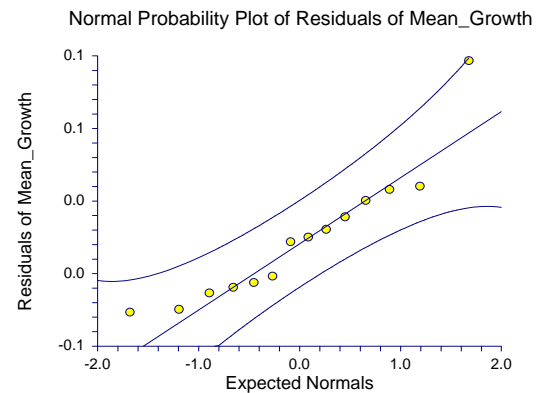
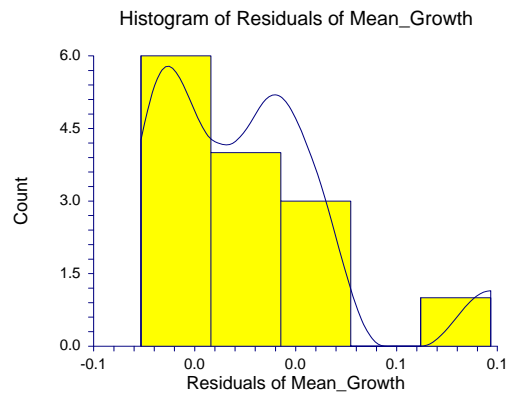
Residual Report

Row	Actual Mean_Growth	Predicted Mean_Growth	Residual	Absolute Percent Error	Sqrt(MSE) Without This Row
6		0.057			

Regression Diagnostics Section

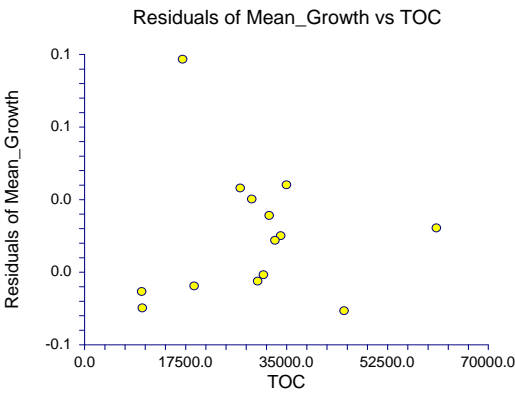
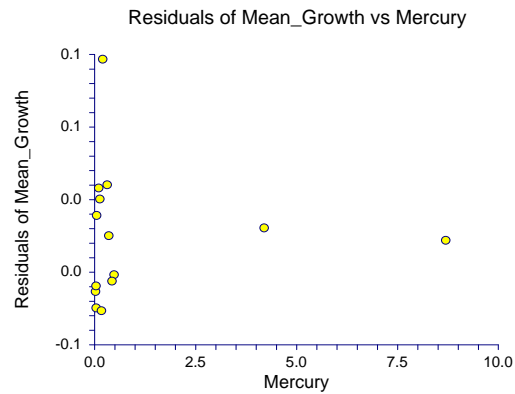
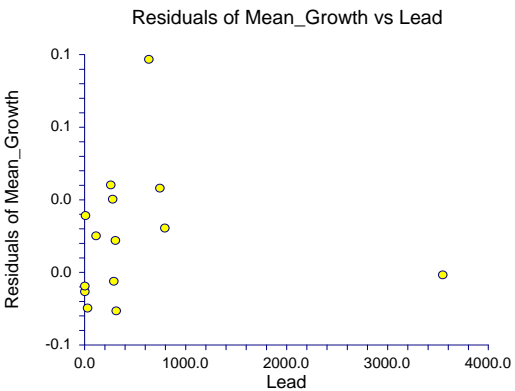
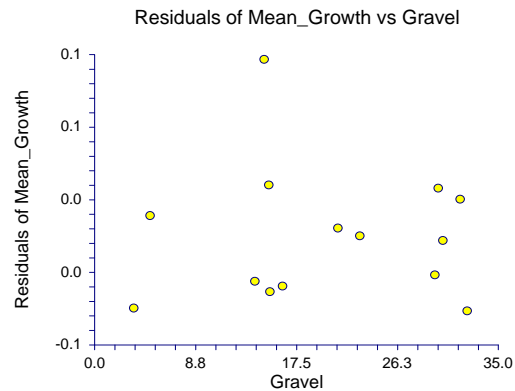
Row	Standardized Residual	RStudent	Hat Diagonal	Cook's D	Dffits	CovRatio
5	-1.8798	-2.3533	0.9409	9.3793	-9.3913	1.1422
11	-2.6138	-6.3986	0.8866	8.9013	-17.8903	0.0002
13	2.5968	6.1288	0.3607	0.6341	4.6037	0.0001

Plots Section



Multiple Regression Report

Page/Date/Time 4 9/11/2009 11:36:13 AM
Database
Dependent Mean_Growth



All Regression Report

Page/Date/Time 1 9/11/2009 11:11:19 AM

Database

Dependent ArcSinSqrt_Survival

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
1	0.428285	0.3979453	-1.460101	A (Antimony)
1	0.072862	0.5067639	4.470643	I (Gravel)
1	0.070626	0.5073746	4.507955	J (Sand)
1	0.059902	0.5102934	4.686892	G (pH28)
1	0.057709	0.5108883	4.723489	C (Lead)
1	0.049749	0.5130416	4.856313	B (Copper)
1	0.039267	0.5158635	5.031224	H (TOC)
1	0.038521	0.5160637	5.043669	E (Zinc)
1	0.008669	0.5240139	5.541799	D (Mercury)
1	0.002891	0.5255389	5.638216	F (pH0)
1	0.000376	0.5262011	5.680170	K (Fines)
2	0.494034	0.3896504	-0.557225	AB
2	0.461848	0.4018528	-0.020154	AH
2	0.437758	0.4107487	0.381824	AE
2	0.434949	0.4117733	0.428690	AC
2	0.433547	0.412284	0.452094	AG
2	0.431191	0.4131404	0.491399	AD
2	0.430780	0.4132897	0.498262	AJ
2	0.429907	0.4136066	0.512832	AF
2	0.429396	0.413792	0.521362	AK
2	0.428290	0.4141928	0.539814	AI
3	0.553117	0.3824775	0.456897	ABH
3	0.506448	0.401953	1.235634	ABK
3	0.506069	0.4021074	1.241959	ABJ
3	0.502714	0.4034706	1.297936	ABC
3	0.500119	0.404522	1.341241	ABI
3	0.500012	0.4045653	1.343026	ABF
3	0.494479	0.4067977	1.435354	ABG
3	0.494400	0.4068295	1.436672	ABE
3	0.494281	0.4068771	1.438648	ABD
3	0.487772	0.4094872	1.547264	AGH
4	0.751589	0.2990824	-0.854897	AIJK
4	0.572205	0.3924849	2.138380	ABCH
4	0.563058	0.3966587	2.291011	ABDH
4	0.558292	0.398816	2.370530	ABGH
4	0.556122	0.3997945	2.406743	ABHJ
4	0.554664	0.4004508	2.431080	ABFH
4	0.554188	0.4006647	2.439022	ABHK
4	0.553542	0.4009549	2.449803	ABEH
4	0.553171	0.4011213	2.455987	ABHI
4	0.534577	0.4093822	2.766255	FIJK

All Possible Regression Report

Page/Date/Time 2 9/11/2009 11:11:19 AM
 Database
 Dependent ArcSinSqrt_Survival

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
5	0.771725	0.3022127	0.809093	AFIJK
5	0.764399	0.3070241	0.931345	ABIIJK
5	0.758326	0.3109559	1.032681	AGIJK
5	0.753512	0.3140376	1.113007	AEIJK
5	0.753356	0.3141371	1.115614	ADIIJK
5	0.752606	0.3146143	1.128127	ACIJK
5	0.752067	0.3149568	1.137119	AHIJK
5	0.588692	0.4056647	3.863264	ABDGH
5	0.584248	0.4078506	3.937427	ABCDH
5	0.578865	0.4104826	4.027253	ABCHK
6	0.776305	0.3173133	2.732676	AFHIJK
6	0.776134	0.3174343	2.735524	ABFIJK
6	0.775493	0.3178889	2.746229	ACFIJK
6	0.774957	0.3182678	2.755165	AFGIJK
6	0.772184	0.320223	2.801444	ADFIJK
6	0.771760	0.320521	2.808523	AEFIJK
6	0.767759	0.3233179	2.875281	ABCIJK
6	0.767422	0.3235522	2.880899	ABGIJK
6	0.766673	0.3240725	2.893392	ABHIJK
6	0.765030	0.3252121	2.920821	ABEIJJK
7	0.781974	0.3348964	4.638084	ABFHIJK
7	0.781890	0.3349609	4.639485	AFGHIJK
7	0.781453	0.335296	4.646772	ABCFIJK
7	0.781128	0.3355453	4.652197	ACFHIJK
7	0.778080	0.3378733	4.703050	ABFGIJK
7	0.777972	0.337956	4.704862	ACFGIJK
7	0.776797	0.3388489	4.724464	AEFHIJK
7	0.776349	0.3391888	4.731940	ADFHIJK
7	0.776218	0.3392883	4.734131	ABEFIJK
7	0.776195	0.3393058	4.734516	ABDFIJK
8	0.795543	0.3502924	6.411666	ADFGHIJK
8	0.789034	0.3558246	6.520276	ABCFHIJK
8	0.785812	0.3585315	6.574041	ABFGHIJK
8	0.785787	0.3585521	6.574453	ACFGHIJK
8	0.783613	0.3603673	6.610736	AEFGHIJK
8	0.782830	0.3610186	6.623799	ABDFHIJK
8	0.782778	0.3610617	6.624664	ABEFHIJK
8	0.782537	0.3612623	6.628692	ABCFGIJK
8	0.781663	0.3619871	6.643268	ACDFHIJK
8	0.781589	0.3620481	6.644497	ABCEFIJK

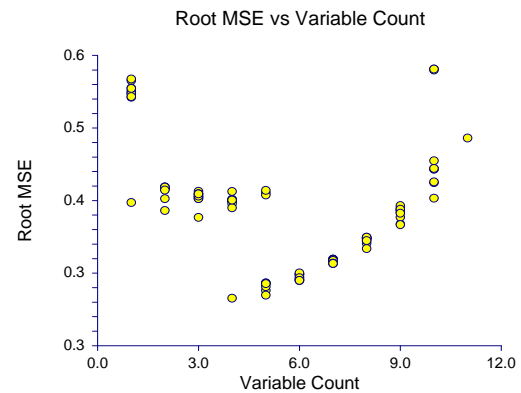
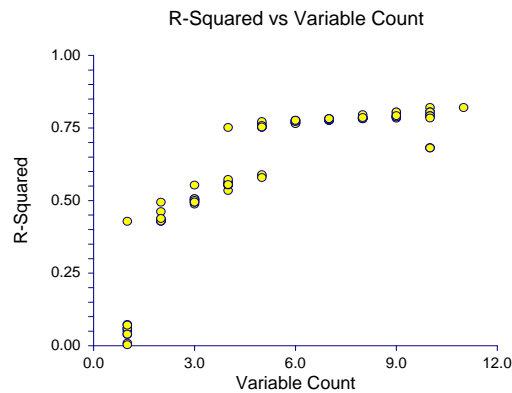
All Possible Regression Report

Page/Date/Time 3 9/11/2009 11:11:19 AM
 Database
 Dependent ArcSinSqrt_Survival

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
9	0.804732	0.3750037	8.258328	ACDFGHIJK
9	0.804171	0.3755425	8.267698	ABDFGHIJK
9	0.796686	0.3826519	8.392591	ADEFGHIJK
9	0.792237	0.386816	8.466829	ABCDGHIJK
9	0.791645	0.3873664	8.476703	ABCFGHIJK
9	0.789084	0.3897402	8.519445	ABCEFGHIJK
9	0.788615	0.3901725	8.527257	ABCDGHIJK
9	0.787741	0.3909788	8.541849	ABEFGHIJK
9	0.786358	0.3922504	8.564925	ACEFGHIJK
9	0.783668	0.3947118	8.609807	ABCDGHIJK
10	0.820166	0.4023564	10.000789	ABCDGHIJK
10	0.805464	0.4184807	10.246120	ABDEFGHIJK
10	0.804738	0.4192606	10.258230	ACDEFGHIJK
10	0.792376	0.4323287	10.464510	ABCDEFHIJK
10	0.792136	0.4325787	10.468518	ABCEFGHIJK
10	0.791603	0.4331323	10.477402	ABCDEGHIJK
10	0.783916	0.441049	10.605681	ABCDEFGIJK
10	0.682203	0.5348725	12.302911	ABCDEFHJK
10	0.681076	0.5358198	12.321710	ABCDEFHJ
10	0.681072	0.5358229	12.321771	ABCDEFHJK
11	0.820213	0.46454	12.000000	ABCDEFGHIJK

Plots Section

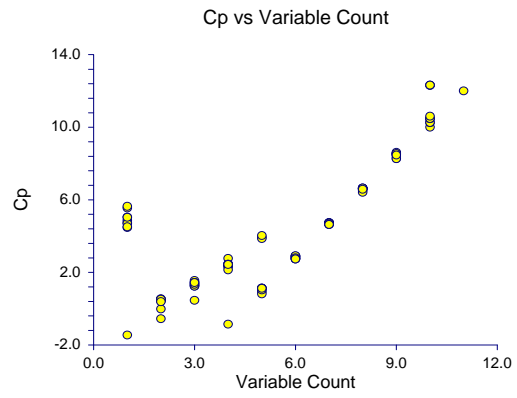


All Possible Regression Report

Page/Date/Time 4 9/11/2009 11:11:19 AM

Database

Dependent ArcSinSqrt_Survival



Multiple Regression Report

Page/Date/Time 1 9/11/2009 11:39:40 AM

Database

Dependent ArcSinSqrt_Survival

Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	ArcSinSqrt_Survival	Rows Processed	16
Number Ind. Variables	5	Rows Filtered Out	0
Weight Variable	None	Rows with X's Missing	1
R2	0.7717	Rows with Weight Missing	0
Adj R2	0.6449	Rows with Y Missing	0
Coefficient of Variation	0.2342	Rows Used in Estimation	15
Mean Square Error	9.133252E-02	Sum of Weights	15.000
Square Root of MSE	0.3022127	Completion Status	Normal Completion
Ave Abs Pct Error	44.041		

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Minimum	Maximum
Antimony	15	4.092	9.172407	0.17	36
Fines	15	42.23333	18.11651	19	81.6
Gravel	15	21.30667	10.49391	3.4	38.6
pH0	15	7.946667	0.5330058	7	8.7
Sand	15	36.46	11.91229	13.6	49.3
ArcSinSqrt_Survival	15	1.290667	0.5071555	0	1.57

Regression Equation Section

Independent Variable	Regression Coefficient b(i)	Standard Error Sb(i)	T-Value to test H0:B(i)=0	Prob Level	Reject H0 at 5%?	Power of Test at 5%
Intercept	824.7130	224.9447	3.666	0.0052	Yes	0.9023
Antimony	-0.0371	0.0121	-3.058	0.0136	Yes	0.7766
Fines	-8.2462	2.2534	-3.659	0.0052	Yes	0.9013
Gravel	-8.2500	2.2542	-3.660	0.0052	Yes	0.9013
pH0	0.1630	0.1830	0.891	0.3961	No	0.1258
Sand	-8.2425	2.2531	-3.658	0.0052	Yes	0.9011

Estimated Model

824.712991502615-3.70907698332625E-02*Antimony-8.24623400657949*Fines-8.24995797289954*Gravel+.16301198360275*pH0-8.24248209585941*Sand

Multiple Regression Report

Page/Date/Time 2 9/11/2009 11:39:40 AM

Database

Dependent ArcSinSqrt_Survival

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	824.7130	224.9447	315.8527	1333.5733	0.0000
Antimony	-0.0371	0.0121	-0.0645	-0.0097	-0.6708
Fines	-8.2462	2.2534	-13.3438	-3.1486	-294.5705
Gravel	-8.2500	2.2542	-13.3494	-3.1506	-170.7056
pH0	0.1630	0.1830	-0.2509	0.5769	0.1713
Sand	-8.2425	2.2531	-13.3393	-3.1456	-193.6030

Note: The T-Value used to calculate these confidence limits was 2.262.

Analysis of Variance Section

Source	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		24.98731	24.98731			
Model	5	0.7717	2.778901	0.5557801	6.085	0.0099	0.9055
Error	9	0.2283	0.8219926	9.133252E-02			
Total(Adjusted)	14	1.0000	3.600893	0.2572067			

Analysis of Variance Detail Section

Model Term	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		24.98731	24.98731			
Model	5	0.7717	2.778901	0.5557801	6.085	0.0099	0.9055
Antimony	1	0.2371	0.8539454	0.8539454	9.350	0.0136	0.7766
Fines	1	0.3397	1.223067	1.223067	13.391	0.0052	0.9013
Gravel	1	0.3397	1.223306	1.223306	13.394	0.0052	0.9013
pH0	1	0.0201	7.251011E-02	7.251011E-02	0.794	0.3961	0.1258
Sand	1	0.3394	1.222309	1.222309	13.383	0.0052	0.9011
Error	9	0.2283	0.8219926	9.133252E-02			
Total(Adjusted)	14	1.0000	3.600893	0.2572067			

Normality Tests Section

Test Name	Test Value	Prob Level	Reject H0 At Alpha = 20%?
Shapiro Wilk	0.8072	0.004555	Yes
Anderson Darling	1.4496	0.000965	Yes
D'Agostino Skewness	-0.9087	0.363496	No
D'Agostino Kurtosis	1.8484	0.064546	Yes
D'Agostino Omnibus	4.2423	0.119893	Yes

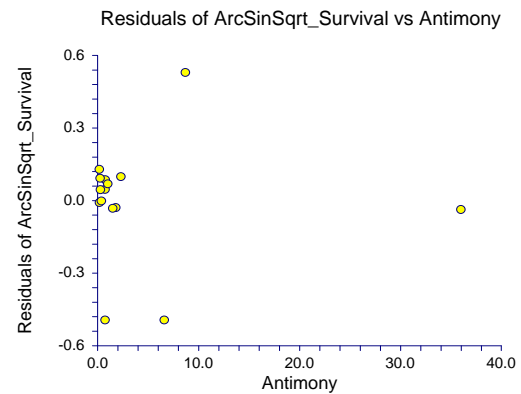
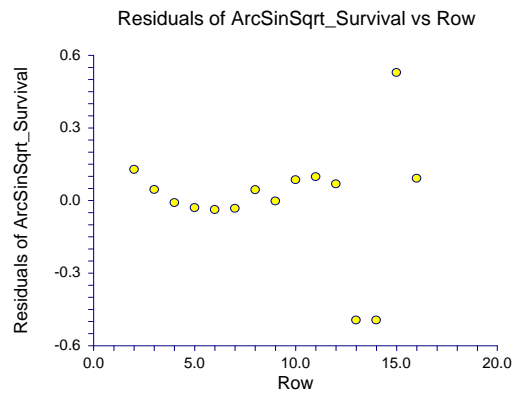
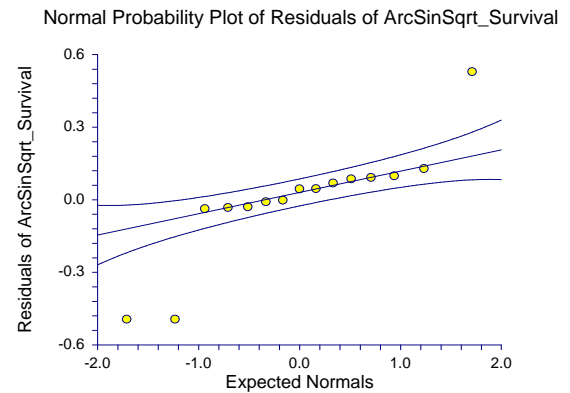
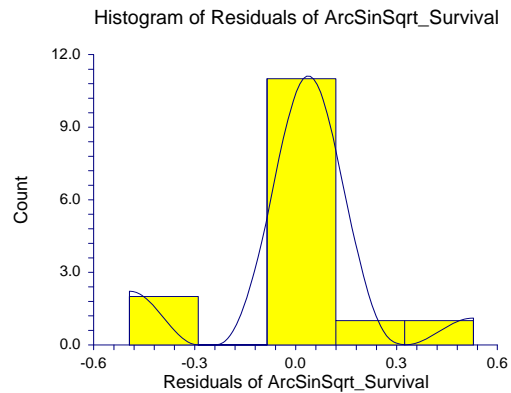
Multiple Regression Report

Page/Date/Time 3 9/11/2009 11:39:40 AM
Database
Dependent ArcSinSqrt_Survival

Regression Diagnostics Section

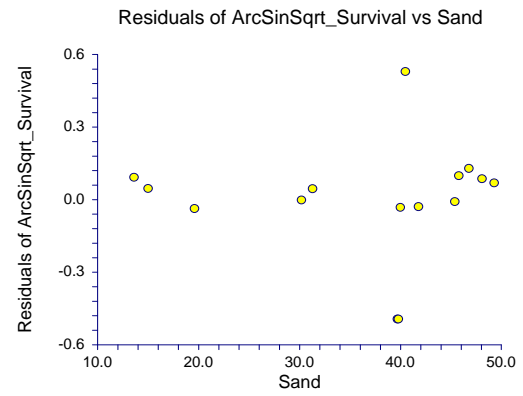
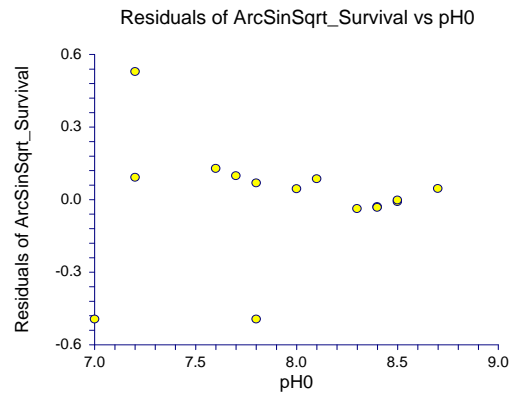
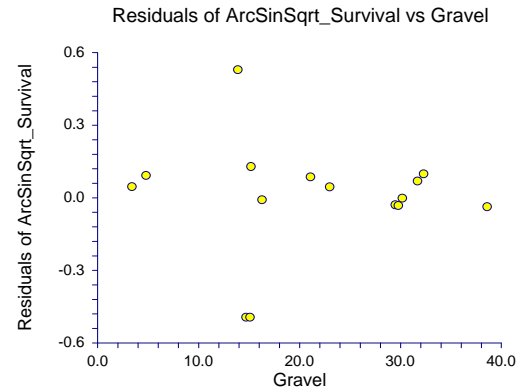
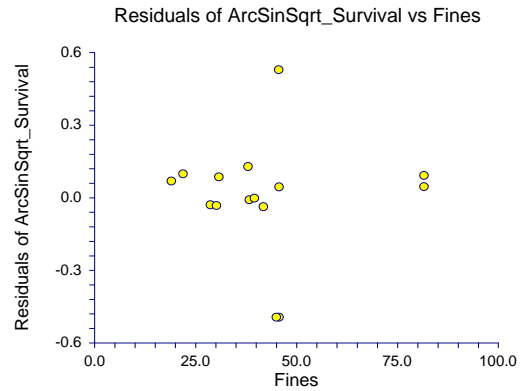
Row	Standardized Residual	RStudent	Hat Diagonal	Cook's D	Dffits	CovRatio
13	-2.8280	-7.9883	0.6664	2.6632	-11.2917	0.0000
14	-2.8280	-7.9883	0.6664	2.6632	-11.2917	0.0000
15	2.1153	2.8123	0.3146	0.3423	1.9054	0.0478

Plots Section



Multiple Regression Report

Page/Date/Time 4 9/11/2009 11:39:40 AM
Database
Dependent ArcSinSqrt_Survival



APPENDIX I
95 PERCENT UCL OF THE MEAN ECOLOGICAL COC
CONCENTRATIONS IN SWMU 2 EARTHWORM TISSUE

Antimony
SWMU 2 Earthworm Tissue

General Statistics

Number of Valid Data	11	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	5
		Percent Non-Detects	45.45%

Raw Statistics

Minimum Detected	0.45
Maximum Detected	1.188
Mean of Detected	0.738
SD of Detected	0.258
Minimum Non-Detect	0.406
Maximum Non-Detect	8.125

Log-transformed Statistics

Minimum Detected	-0.799
Maximum Detected	0.172
Mean of Detected	-0.353
SD of Detected	0.338
Minimum Non-Detect	-0.901
Maximum Non-Detect	2.095

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	11
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions
It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.93
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.978
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.852
SD	1.11
95% DL/2 (t) UCL	1.458

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-0.614
SD	0.909
95% H-Stat (DL/2) UCL	1.688

Maximum Likelihood Estimate(MLE) Method N/A
MLE method failed to converge properly

Log ROS Method	
Mean in Log Scale	-0.684
SD in Log Scale	0.473
Mean in Original Scale	0.56
SD in Original Scale	0.28
95% Percentile Bootstrap UCL	0.694
95% BCA Bootstrap UCL	0.728

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.355
Theta Star	0.138
nu star	64.27

A-D Test Statistic	0.218
5% A-D Critical Value	0.698
K-S Test Statistic	0.698
5% K-S Critical Value	0.332

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only
Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.623
SD	0.231
SE of Mean	0.0799
95% KM (t) UCL	0.767
95% KM (z) UCL	0.754
95% KM (jackknife) UCL	0.755
95% KM (bootstrap t) UCL	0.803
95% KM (BCA) UCL	0.835
95% KM (Percentile Bootstrap) UCL	0.805
95% KM (Chebyshev) UCL	0.971
97.5% KM (Chebyshev) UCL	1.121
99% KM (Chebyshev) UCL	1.417

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.45
Maximum	1.188
Mean	0.714
Median	0.684
SD	0.222
k star	9.219
Theta star	0.0775
Nu star	202.8
AppChi2	170.9
95% Gamma Approximate UCL	0.848
95% Adjusted Gamma UCL	0.872

Note: DL/2 is not a recommended method.

Potential UCLs to use:

95% KM (t) UCL	0.767
95% KM (Percentile Bootstrap) UCL	0.805

Copper
SWMU 2 Earthworm Tissue

General Statistics					
	Number of Valid Observations	11		Number of Distinct Observations	10
Raw Statistics			Log-transformed Statistics		
	Minimum	13.75		Minimum of Log Data	2.621
	Maximum	87.5		Maximum of Log Data	4.472
	Mean	34.89		Mean of log Data	3.418
	Median	28.75		SD of log Data	0.517
	SD	21.53			
	Coefficient of Variation	0.617			
	Skewness	1.828			
Relevant UCL Statistics					
Normal Distribution Test			Lognormal Distribution Test		
	Shapiro Wilk Test Statistic	0.78		Shapiro Wilk Test Statistic	0.932
	Shapiro Wilk Critical Value	0.85		Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level			Data appear Lognormal at 5% Significance Level		
Assuming Normal Distribution			Assuming Lognormal Distribution		
	95% Student's-t UCL	46.65		95% H-UCL	49.95
	95% UCLs (Adjusted for Skewness)			95% Chebyshev (MVUE) UCL	58.3
	95% Adjusted-CLT UCL	49.39		97.5% Chebyshev (MVUE) UCL	68.64
	95% Modified-t UCL	47.25		99% Chebyshev (MVUE) UCL	88.96
Gamma Distribution Test			Data Distribution		
	k star (bias corrected)	2.88	Data appear Gamma Distributed at 5% Significance Level		
	Theta Star	12.11			
	MLE of Mean	34.89	Nonparametric Statistics		
	MLE of Standard Deviation	20.56		95% CLT UCL	45.57
	nu star	63.36		95% Jackknife UCL	46.65
	Approximate Chi Square Value (.05)	46.05		95% Standard Bootstrap UCL	44.98
	Adjusted Level of Significance	0.0278		95% Bootstrap-t UCL	64.98
	Adjusted Chi Square Value	43.65		95% Hall's Bootstrap UCL	111.6
	Anderson-Darling Test Statistic	0.608		95% Percentile Bootstrap UCL	45.63
	Anderson-Darling 5% Critical Value	0.733		95% BCA Bootstrap UCL	48.18
	Kolmogorov-Smirnov Test Statistic	0.248		95% Chebyshev(Mean, Sd) UCL	63.19
	Kolmogorov-Smirnov 5% Critical Value	0.257		97.5% Chebyshev(Mean, Sd) UCL	75.43
Data appear Gamma Distributed at 5% Significance Level				99% Chebyshev(Mean, Sd) UCL	99.48
Assuming Gamma Distribution			Potential UCL to use:		
	95% Approximate Gamma UCL	48	Use 95% Approximate Gamma UCL		
	95% Adjusted Gamma UCL	50.64			

Lead**SWMU 2 Earthworm Tissue**

General Statistics

Number of Valid Observations 11

Number of Distinct Observations 10

Raw Statistics

Minimum 3.625
Maximum 47.5
Mean 16.11
Median 10.63
SD 13.24
Coefficient of Variation 0.822
Skewness 1.523

Log-transformed Statistics

Minimum of Log Data 1.288
Maximum of Log Data 3.861
Mean of log Data 2.506
SD of log Data 0.766

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.959
Shapiro Wilk Critical Value 0.85

Data appear Lognormal at 5% Significance Level

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.822
Shapiro Wilk Critical Value 0.85

Data not Normal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL 30.68
95% Chebyshev (MVUE) UCL 32.63
97.5% Chebyshev (MVUE) UCL 39.86
99% Chebyshev (MVUE) UCL 54.06

Assuming Normal Distribution

95% Student's-t UCL 23.35
95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL 24.64
95% Modified-t UCL 23.65

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Gamma Distribution Test

k star (bias corrected) 1.501
Theta Star 10.74
MLE of Mean 16.11
MLE of Standard Deviation 13.15
nu star 33.02
Approximate Chi Square Value (.05) 20.88
Adjusted Level of Significance 0.0278
Adjusted Chi Square Value 19.32
Anderson-Darling Test Statistic 0.453
Anderson-Darling 5% Critical Value 0.739
Kolmogorov-Smirnov Test Statistic 0.255
Kolmogorov-Smirnov 5% Critical Value 0.259

Nonparametric Statistics

95% CLT UCL 22.68
95% Jackknife UCL 23.35
95% Standard Bootstrap UCL 22.43
95% Bootstrap-t UCL 27.92
95% Hall's Bootstrap UCL 24.93
95% Percentile Bootstrap UCL 23.1
95% BCA Bootstrap UCL 24.4
95% Chebyshev(Mean, Sd) UCL 33.51
97.5% Chebyshev(Mean, Sd) UCL 41.04
99% Chebyshev(Mean, Sd) UCL 55.83

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 25.48
95% Adjusted Gamma UCL 27.54

Potential UCL to use:**Use 95% Approximate Gamma UCL 25.48**

Mercury
SWMU 2 Earthworm Tissue

General Statistics					
	Number of Valid Data	11	Number of Detected Data	10	
	Number of Distinct Detected Data	10	Number of Non-Detect Data	1	
			Percent Non-Detects	9.09%	
Raw Statistics			Log-transformed Statistics		
Minimum Detected	0.075		Minimum Detected	-2.59	
Maximum Detected	1.313		Maximum Detected	0.272	
Mean of Detected	0.501		Mean of Detected	-1.017	
SD of Detected	0.407		SD of Detected	0.915	
Minimum Non-Detect	4.688		Minimum Non-Detect	1.545	
Maximum Non-Detect	4.688		Maximum Non-Detect	1.545	
UCL Statistics					
Normal Distribution Test with Detected Values Only			Lognormal Distribution Test with Detected Values Only		
	Shapiro Wilk Test Statistic	0.833		Shapiro Wilk Test Statistic	0.917
	5% Shapiro Wilk Critical Value	0.842		5% Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level			Data appear Lognormal at 5% Significance Level		
Assuming Normal Distribution			Assuming Lognormal Distribution		
	DL/2 Substitution Method			DL/2 Substitution Method	
	Mean	0.669		Mean	-0.847
	SD	0.677		SD	1.035
	95% DL/2 (t) UCL	1.038		95% H-Stat (DL/2) UCL	2.976
Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method	
MLE method failed to converge properly				Mean in Log Scale	-1.017
				SD in Log Scale	0.868
Gamma Distribution Test with Detected Values Only				Mean in Original Scale	0.489
	k star (bias corrected)	1.244		SD in Original Scale	0.388
	Theta Star	0.403		95% Percentile Bootstrap UCL	0.685
	nu star	24.87		95% BCA Bootstrap UCL	0.736
	A-D Test Statistic	0.399	Data Distribution Test with Detected Values Only		
	5% A-D Critical Value	0.738	Data appear Gamma Distributed at 5% Significance Level		
	K-S Test Statistic	0.738			
	5% K-S Critical Value	0.271	Nonparametric Statistics		
Data appear Gamma Distributed at 5% Significance Level				Kaplan-Meier (KM) Method	
				Mean	0.501
Assuming Gamma Distribution				SD	0.386
	Gamma ROS Statistics using Extrapolated Data			SE of Mean	0.129
	Minimum	0.075		95% KM (t) UCL	0.734
	Maximum	1.313		95% KM (z) UCL	0.713
	Mean	0.502		95% KM (jackknife) UCL	0.736
	Median	0.444		95% KM (bootstrap t) UCL	0.995
	SD	0.386		95% KM (BCA) UCL	0.714
	k star	1.396		95% KM (Percentile Bootstrap) UCL	0.706
	Theta star	0.36		95% KM (Chebyshev) UCL	1.062
	Nu star	30.71		97.5% KM (Chebyshev) UCL	1.305
	AppChi2	19.05		99% KM (Chebyshev) UCL	1.782
	95% Gamma Approximate UCL	0.81			
	95% Adjusted Gamma UCL	0.878			
Note: DL/2 is not a recommended method.			Potential UCL to use:		
			95% KM (Chebyshev) UCL		
			1.062		

Zinc**SWMU 2 Earthworm Tissue**

General Statistics

Number of Valid Observations 11

Number of Distinct Observations 7

Raw Statistics

Minimum 100
Maximum 506.3
Mean 151.7
Median 112.5
SD 118.5
Coefficient of Variation 0.781
Skewness 3.231

Log-transformed Statistics

Minimum of Log Data 4.605
Maximum of Log Data 6.227
Mean of log Data 4.883
SD of log Data 0.461

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.564
Shapiro Wilk Critical Value 0.85

Data not Lognormal at 5% Significance Level

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.447
Shapiro Wilk Critical Value 0.85

Data not Normal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL 200.1
95% Chebyshev (MVUE) UCL 234.8
97.5% Chebyshev (MVUE) UCL 273.6
99% Chebyshev (MVUE) UCL 349.7

Assuming Normal Distribution

95% Student's-t UCL 216.4
95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL 247.6
95% Modified-t UCL 222.2

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL 210.5
95% Jackknife UCL 216.4
95% Standard Bootstrap UCL 207.7
95% Bootstrap-t UCL 649.7
95% Hall's Bootstrap UCL 468.4
95% Percentile Bootstrap UCL 221.6
95% BCA Bootstrap UCL 257.4
95% Chebyshev(Mean, Sd) UCL 307.4
97.5% Chebyshev(Mean, Sd) UCL 374.8
99% Chebyshev(Mean, Sd) UCL 507.1

Gamma Distribution Test

k star (bias corrected) 2.796
Theta Star 54.26
MLE of Mean 151.7
MLE of Standard Deviation 90.73
nu star 61.51
Approximate Chi Square Value (.05) 44.47
Adjusted Level of Significance 0.0278
Adjusted Chi Square Value 42.12

Anderson-Darling Test Statistic 2.357
Anderson-Darling 5% Critical Value 0.733
Kolmogorov-Smirnov Test Statistic 0.358
Kolmogorov-Smirnov 5% Critical Value 0.257

Data not Gamma Distributed at 5% Significance Level

Potential UCL to use:

95% Student's-t UCL 216.4
95% Modified-t UCL 222.2

Assuming Gamma Distribution

95% Approximate Gamma UCL 209.8
95% Adjusted Gamma UCL 221.5

APPENDIX J
95 PERCENT UCL OF THE MEAN ECOLOGICAL COC
CONCENTRATIONS IN SWMU 2 EUSTARINE WETLAND
SEDIMENT

Copper
SWMU 2 Estuarine Wetland Sediment

General Statistics					
	Number of Valid Observations	42		Number of Distinct Observations	34
Raw Statistics			Log-transformed Statistics		
	Minimum	10		Minimum of Log Data	2.303
	Maximum	710		Maximum of Log Data	6.565
	Mean	108.2		Mean of log Data	4.204
	Median	80.5		SD of log Data	1.036
	SD	121.7			
	Coefficient of Variation	1.125	Lognormal Distribution Test		
	Skewness	3.249		Shapiro Wilk Test Statistic	0.914
				Shapiro Wilk Critical Value	0.942
Relevant UCL Statistics			Data not Lognormal at 5% Significance Level		
Normal Distribution Test			Assuming Lognormal Distribution		
	Shapiro Wilk Test Statistic	0.673		95% H-UCL	168.7
	Shapiro Wilk Critical Value	0.942		95% Chebyshev (MVUE) UCL	204.6
Data not Normal at 5% Significance Level				97.5% Chebyshev (MVUE) UCL	244.5
Assuming Normal Distribution				99% Chebyshev (MVUE) UCL	322.9
	95% Student's-t UCL	139.8	Data Distribution		
	95% UCLs (Adjusted for Skewness)		Data appear Gamma Distributed at 5% Significance Level		
	95% Adjusted-CLT UCL	149.1	Nonparametric Statistics		
	95% Modified-t UCL	141.4		95% CLT UCL	139.1
Gamma Distribution Test				95% Jackknife UCL	139.8
	k star (bias corrected)	1.113		95% Standard Bootstrap UCL	138.7
	Theta Star	97.22		95% Bootstrap-t UCL	158
	MLE of Mean	108.2		95% Hall's Bootstrap UCL	282.5
	MLE of Standard Deviation	102.6		95% Percentile Bootstrap UCL	141.5
	nu star	93.48		95% BCA Bootstrap UCL	150
	Approximate Chi Square Value (.05)	72.18		95% Chebyshev(Mean, Sd) UCL	190.1
	Adjusted Level of Significance	0.0443		97.5% Chebyshev(Mean, Sd) UCL	225.5
	Adjusted Chi Square Value	71.52		99% Chebyshev(Mean, Sd) UCL	295.1
	Anderson-Darling Test Statistic	0.423	Potential UCL to Use		
	Anderson-Darling 5% Critical Value	0.774	95% Approximate Gamma UCL		
	Kolmogorov-Smirnov Test Statistic	0.0957	140.1 mg/kg		
	Kolmogorov-Smirnov 5% Critical Value	0.14			
Data appear Gamma Distributed at 5% Significance Level					
Assuming Gamma Distribution					
	95% Approximate Gamma UCL	140.1			
	95% Adjusted Gamma UCL	141.4			

Lead**SWMU 2 Estuarine Wetland Sediment**

General Statistics

Number of Valid Observations	40
Number of Missing Values	2

Number of Distinct Observations 36

Raw Statistics

Minimum	1.2
Maximum	450
Mean	51.29
Median	16.5
SD	101.4
Coefficient of Variation	1.977
Skewness	3.246

Log-transformed Statistics

Minimum of Log Data	0.182
Maximum of Log Data	6.109
Mean of Log Data	2.805
SD of Log Data	1.461

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.959
Shapiro Wilk Critical Value	0.94

Data appear Lognormal at 5% Significance Level

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.509
Shapiro Wilk Critical Value	0.94

Data not Normal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL	96.83
95% Chebyshev (MVUE) UCL	105
97.5% Chebyshev (MVUE) UCL	130.6
99% Chebyshev (MVUE) UCL	181.1

Assuming Normal Distribution

95% Student's-t UCL	78.3
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL	86.45
95% Modified-t UCL	79.67

Data Distribution

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	77.66
95% Jackknife UCL	78.3
95% Standard Bootstrap UCL	77.47
95% Bootstrap-t UCL	108.4
95% Hall's Bootstrap UCL	115.8
95% Percentile Bootstrap UCL	80.83
95% BCA Bootstrap UCL	87.13
95% Chebyshev(Mean, Sd) UCL	121.2
97.5% Chebyshev(Mean, Sd) UCL	151.4
99% Chebyshev(Mean, Sd) UCL	210.8

Gamma Distribution Test

k star (bias corrected)	0.528
Theta Star	97.19
MLE of Mean	51.29
MLE of Standard Deviation	70.6
nu star	42.22
Approximate Chi Square Value (.05)	28.32
Adjusted Level of Significance	0.044
Adjusted Chi Square Value	27.89
Anderson-Darling Test Statistic	2.059
Anderson-Darling 5% Critical Value	0.808
Kolmogorov-Smirnov Test Statistic	0.195
Kolmogorov-Smirnov 5% Critical Value	0.147

Data not Gamma Distributed at 5% Significance Level

Potential UCL to use:**95% H-UCL 96.83**

Assuming Gamma Distribution

95% Approximate Gamma UCL	76.45
95% Adjusted Gamma UCL	77.62

Mercury
SWMU 2 Estuarine Wetland Sediment

General Statistics					
	Number of Valid Observations	40		Number of Distinct Observations	33
	Number of Missing Values	2			
Raw Statistics			Log-transformed Statistics		
	Minimum	0.015		Minimum of Log Data	-4.2
	Maximum	1.3		Maximum of Log Data	0.262
	Mean	0.172		Mean of log Data	-2.378
	Median	0.0935		SD of log Data	1.094
	SD	0.242			
	Coefficient of Variation	1.407	Lognormal Distribution Test		
	Skewness	3.247		Shapiro Wilk Test Statistic	0.96
				Shapiro Wilk Critical Value	0.94
Relevant UCL Statistics			Data appear Lognormal at 5% Significance Level		
Normal Distribution Test			Assuming Lognormal Distribution		
	Shapiro Wilk Test Statistic	0.624		95% H-UCL	0.262
	Shapiro Wilk Critical Value	0.94		95% Chebyshev (MVUE) UCL	0.313
Data not Normal at 5% Significance Level				97.5% Chebyshev (MVUE) UCL	0.377
				99% Chebyshev (MVUE) UCL	0.503
Assuming Normal Distribution			Data Distribution		
	95% Student's-t UCL	0.236		Data appear Lognormal at 5% Significance Level	
95% UCLs (Adjusted for Skewness)			Nonparametric Statistics		
	95% Adjusted-CLT UCL	0.256		95% CLT UCL	0.235
	95% Modified-t UCL	0.24		95% Jackknife UCL	0.236
Gamma Distribution Test				95% Standard Bootstrap UCL	0.233
	k star (bias corrected)	0.887		95% Bootstrap-t UCL	0.284
	Theta Star	0.194		95% Hall's Bootstrap UCL	0.517
	MLE of Mean	0.172		95% Percentile Bootstrap UCL	0.239
	MLE of Standard Deviation	0.183		95% BCA Bootstrap UCL	0.26
	nu star	70.95		95% Chebyshev(Mean, Sd) UCL	0.339
	Approximate Chi Square Value (.05)	52.55		97.5% Chebyshev(Mean, Sd) UCL	0.411
	Adjusted Level of Significance	0.044		99% Chebyshev(Mean, Sd) UCL	0.553
	Adjusted Chi Square Value	51.96			
	Anderson-Darling Test Statistic	1.079	Potential UCL to use:		
	Anderson-Darling 5% Critical Value	0.781		95% H-UCL	0.262
	Kolmogorov-Smirnov Test Statistic	0.149			
	Kolmogorov-Smirnov 5% Critical Value	0.144			
Data not Gamma Distributed at 5% Significance Level					
Assuming Gamma Distribution					
	95% Approximate Gamma UCL	0.232			
	95% Adjusted Gamma UCL	0.235			

Zinc**SWMU 2 Estuarine Wetland Sediment**

General Statistics

Number of Valid Observations	32
Number of Missing Values	10

Number of Distinct Observations	27
---------------------------------	----

Raw Statistics

Minimum	10
Maximum	420
Mean	81.28
Median	59.5
SD	92.25
Coefficient of Variation	1.135
Skewness	2.194

Log-transformed Statistics

Minimum of Log Data	2.303
Maximum of Log Data	6.04
Mean of log Data	3.899
SD of log Data	1.006

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.951
Shapiro Wilk Critical Value	0.93

Data appear Lognormal at 5% Significance Level

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.726
Shapiro Wilk Critical Value	0.93

Data not Normal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL	127.2
95% Chebyshev (MVUE) UCL	151.7
97.5% Chebyshev (MVUE) UCL	182.6
99% Chebyshev (MVUE) UCL	243.5

Assuming Normal Distribution

95% Student's-t UCL	108.9
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL	114.9
95% Modified-t UCL	110

Data Distribution

Data Follow Appr. Gamma Distribution at 5% Significance Level

Gamma Distribution Test

k star (bias corrected)	1.054
Theta Star	77.09
MLE of Mean	81.28
MLE of Standard Deviation	79.16
nu star	67.48
Approximate Chi Square Value (.05)	49.58
Adjusted Level of Significance	0.0416
Adjusted Chi Square Value	48.76
Anderson-Darling Test Statistic	0.885
Anderson-Darling 5% Critical Value	0.772
Kolmogorov-Smirnov Test Statistic	0.123
Kolmogorov-Smirnov 5% Critical Value	0.16

Data follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	108.1
95% Jackknife UCL	108.9
95% Standard Bootstrap UCL	107.8
95% Bootstrap-t UCL	121.8
95% Hall's Bootstrap UCL	120.2
95% Percentile Bootstrap UCL	107.5
95% BCA Bootstrap UCL	117
95% Chebyshev(Mean, Sd) UCL	152.4
97.5% Chebyshev(Mean, Sd) UCL	183.1
99% Chebyshev(Mean, Sd) UCL	243.5

Potential UCL to use:

95% Approximate Gamma UCL	110.6 mg/kg
----------------------------------	--------------------

Assuming Gamma Distribution

95% Approximate Gamma UCL	110.6
95% Adjusted Gamma UCL	112.5

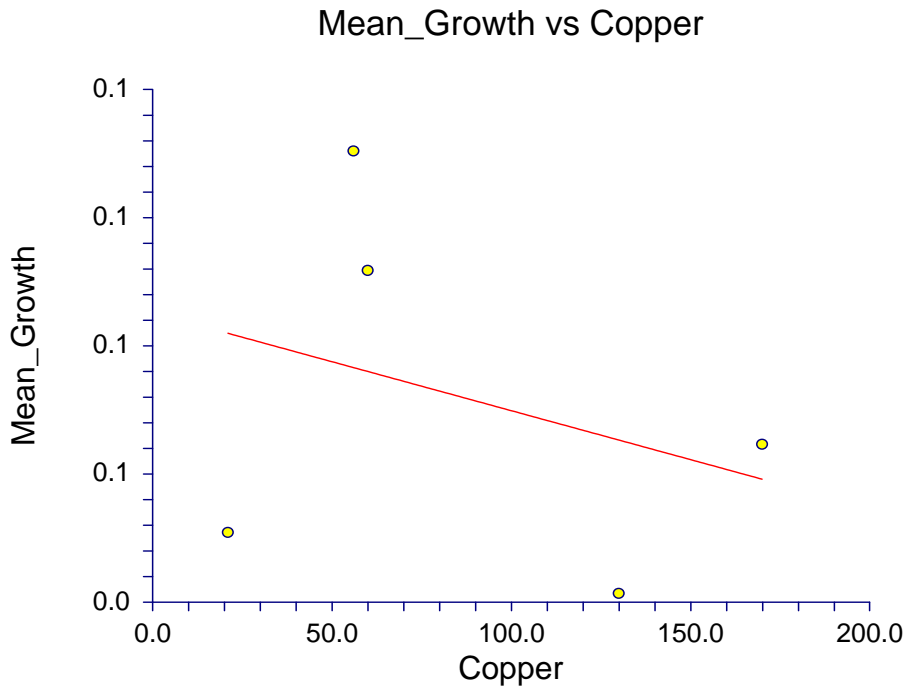
APPENDIX K
REGRESSION REPORTS FOR *LEPTOCHEIRUS PLUMULOSUS*
SURVIVAL AND GROWTH DATA

PAIR-WISE LINEAR REGRESSION REPORTS

Linear Regression Report

Page/Date/Time 1 8/17/2009 2:59:38 PM
Database
Y = Mean_Growth X = Copper

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	Copper	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0964	Rows Prediction Only	5
Slope	-0.0002	Sum of Frequencies	5
R-Squared	0.1044	Sum of Weights	5.0000
Correlation	-0.3231	Coefficient of Variation	0.4922
Mean Square Error	1.541132E-03	Square Root of MSE	3.925725E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:59:38 PM
Y = Mean_Growth X = Copper

Summary Statement

The equation of the straight line relating Mean_Growth and Copper is estimated as: $\text{Mean_Growth} = (0.0964) + (-0.0002) \text{Copper}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Copper is zero, is 0.0964 with a standard error of 0.0332. The slope, the estimated change in Mean_Growth per unit change in Copper, is -0.0002 with a standard error of 0.0003. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Copper, is 0.1044. The correlation between Mean_Growth and Copper is -0.3231.

A significance test that the slope is zero resulted in a t-value of -0.5913. The significance level of this t-test is 0.5959. Since $0.5959 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0002. The lower limit of the 95% confidence interval for the slope is -0.0012 and the upper limit is 0.0008. The estimated intercept is 0.0964. The lower limit of the 95% confidence interval for the intercept is -0.0093 and the upper limit is 0.2022.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Copper
Count	5	5
Mean	0.0798	87.4000
Standard Deviation	0.0359	60.7931
Minimum	0.0417	21.0000
Maximum	0.1280	170.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:59:38 PM

Database

Y = Mean_Growth X = Copper

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0964	-0.0002
Lower 95% Confidence Limit	-0.0093	-0.0012
Upper 95% Confidence Limit	0.2022	0.0008
Standard Error	0.0332	0.0003
Standardized Coefficient	0.0000	-0.3231
T Value	2.9020	-0.5913
Prob Level (T Test)	0.0624	0.5959
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.5084	0.0714
Regression of Y on X	0.0964	-0.0002
Inverse Regression from X on Y	0.2396	-0.0018
Orthogonal Regression of Y and X	0.0964	-0.0002

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(9.64470669408518E-02) + (-1.90927539369013E-04) * (\text{Copper})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	5.388968E-04	5.388968E-04	0.3497	0.5959	0.0714
Error	3	4.623395E-03	1.541132E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(1.541132E-03) = 3.925725E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:59:38 PM

Database

Y = Mean_Growth X = Copper

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9385	0.655152	Yes
Anderson Darling	0.2566	0.722926	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

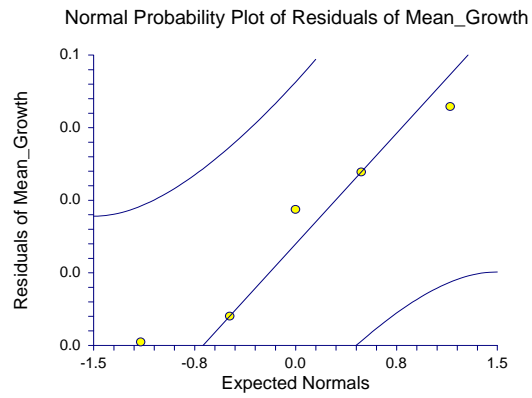
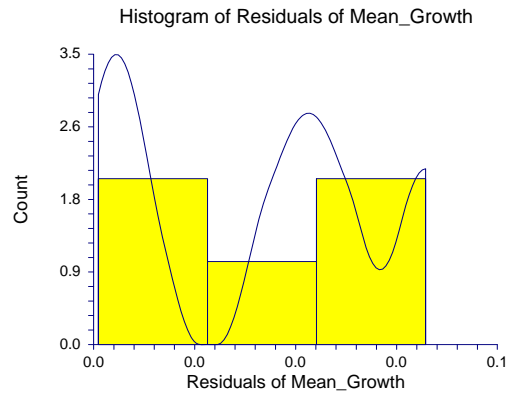
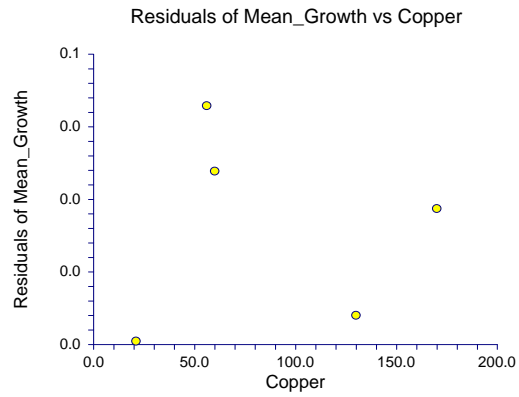
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:59:38 PM

Database

Y = Mean_Growth X = Copper

Residual Plots Section



Linear Regression Report

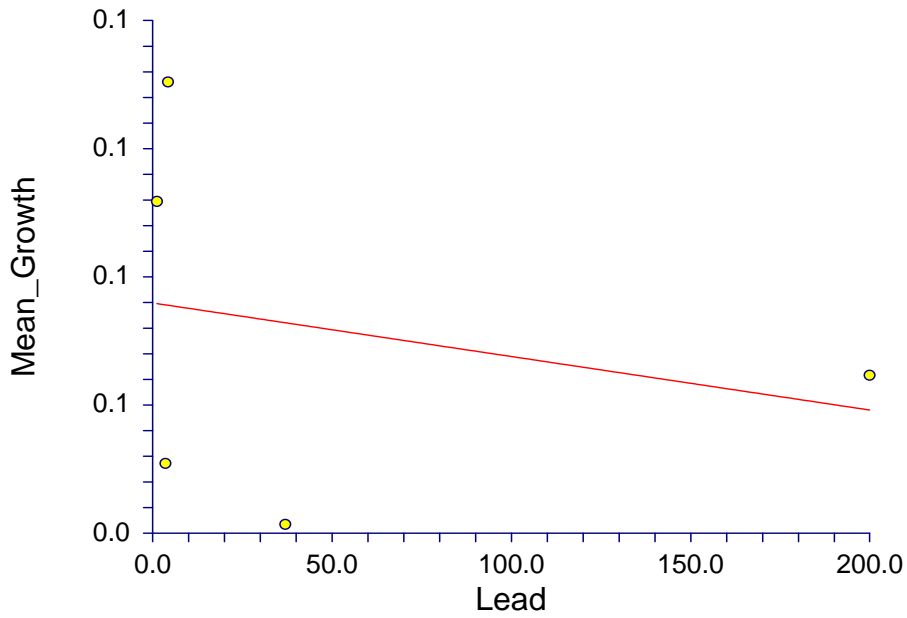
Page/Date/Time 1 8/17/2009 2:59:58 PM

Database

Y = Mean_Growth X = Lead

Linear Regression Plot Section

Mean_Growth vs Lead



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	Lead	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0849	Rows Prediction Only	5
Slope	-0.0001	Sum of Frequencies	5
R-Squared	0.0618	Sum of Weights	5.0000
Correlation	-0.2486	Coefficient of Variation	0.5038
Mean Square Error	1.614404E-03	Square Root of MSE	4.017965E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:59:58 PM
Y = Mean_Growth X = Lead

Summary Statement

The equation of the straight line relating Mean_Growth and Lead is estimated as: $\text{Mean_Growth} = (0.0849) + (-0.0001) \text{Lead}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Lead is zero, is 0.0849 with a standard error of 0.0214. The slope, the estimated change in Mean_Growth per unit change in Lead, is -0.0001 with a standard error of 0.0002. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Lead, is 0.0618. The correlation between Mean_Growth and Lead is -0.2486.

A significance test that the slope is zero resulted in a t-value of -0.4446. The significance level of this t-test is 0.6867. Since $0.6867 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0001. The lower limit of the 95% confidence interval for the slope is -0.0009 and the upper limit is 0.0006. The estimated intercept is 0.0849. The lower limit of the 95% confidence interval for the intercept is 0.0169 and the upper limit is 0.1529.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Lead
Count	5	5
Mean	0.0798	49.2200
Standard Deviation	0.0359	85.5699
Minimum	0.0417	1.2000
Maximum	0.1280	200.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:59:58 PM

Database

Y = Mean_Growth X = Lead

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0849	-0.0001
Lower 95% Confidence Limit	0.0169	-0.0009
Upper 95% Confidence Limit	0.1529	0.0006
Standard Error	0.0214	0.0002
Standardized Coefficient	0.0000	-0.2486
T Value	3.9739	-0.4446
Prob Level (T Test)	0.0285	0.6867
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.7501	0.0621
Regression of Y on X	0.0849	-0.0001
Inverse Regression from X on Y	0.1629	-0.0017
Orthogonal Regression of Y and X	0.0849	-0.0001

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(8.48973584894838E-02) + (-1.04375426442174E-04) * (\text{Lead})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	3.190794E-04	3.190794E-04	0.1976	0.6867	0.0621
Error	3	4.843213E-03	1.614404E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(1.614404E-03) = 4.017965E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:59:58 PM

Database

Y = Mean_Growth X = Lead

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9369	0.644344	Yes
Anderson Darling	0.2593	0.713684	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

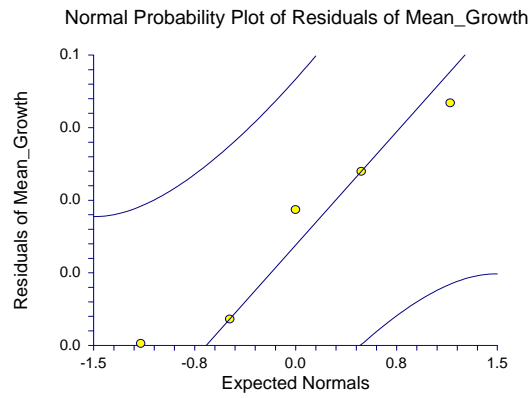
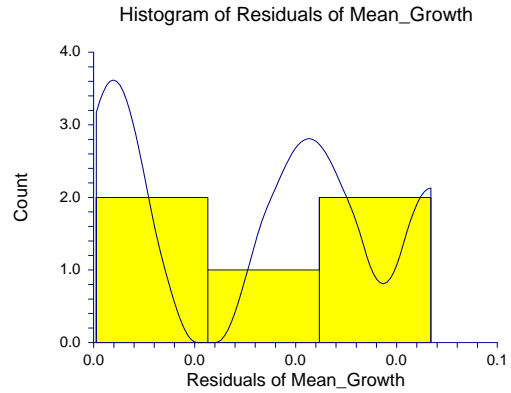
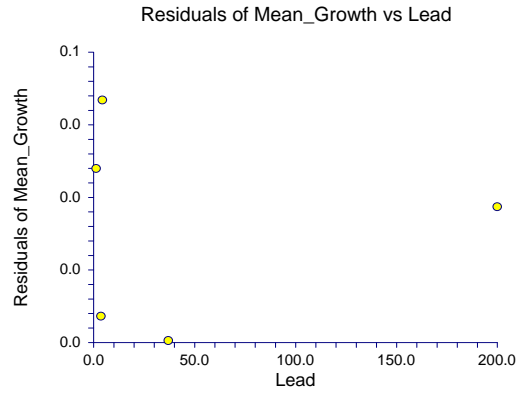
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:59:58 PM

Database

Y = Mean_Growth X = Lead

Residual Plots Section



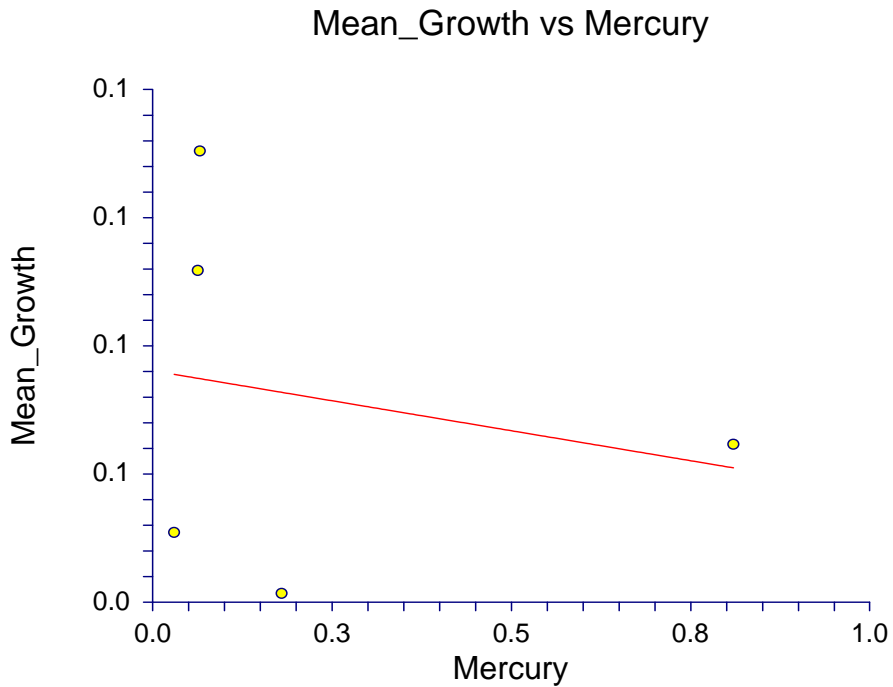
Linear Regression Report

Page/Date/Time 1 8/17/2009 3:00:15 PM

Database

Y = Mean_Growth X = Mercury

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	Mercury	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0851	Rows Prediction Only	5
Slope	-0.0234	Sum of Frequencies	5
R-Squared	0.0459	Sum of Weights	5.0000
Correlation	-0.2143	Coefficient of Variation	0.5080
Mean Square Error	1.641765E-03	Square Root of MSE	0.0405187

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:00:15 PM
Y = Mean_Growth X = Mercury

Summary Statement

The equation of the straight line relating Mean_Growth and Mercury is estimated as: $\text{Mean_Growth} = (0.0851) + (-0.0234) \text{ Mercury}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Mercury is zero, is 0.0851 with a standard error of 0.0230. The slope, the estimated change in Mean_Growth per unit change in Mercury, is -0.0234 with a standard error of 0.0615. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Mercury, is 0.0459. The correlation between Mean_Growth and Mercury is -0.2143.

A significance test that the slope is zero resulted in a t-value of -0.3799. The significance level of this t-test is 0.7293. Since $0.7293 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0234. The lower limit of the 95% confidence interval for the slope is -0.2192 and the upper limit is 0.1724. The estimated intercept is 0.0851. The lower limit of the 95% confidence interval for the intercept is 0.0120 and the upper limit is 0.1583.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Mercury
Count	5	5
Mean	0.0798	0.2298
Standard Deviation	0.0359	0.3293
Minimum	0.0417	0.0300
Maximum	0.1280	0.8100

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:00:15 PM

Database

Y = Mean_Growth X = Mercury

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0851	-0.0234
Lower 95% Confidence Limit	0.0120	-0.2192
Upper 95% Confidence Limit	0.1583	0.1724
Standard Error	0.0230	0.0615
Standardized Coefficient	0.0000	-0.2143
T Value	3.7040	-0.3799
Prob Level (T Test)	0.0342	0.7293
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.6961	0.0588
Regression of Y on X	0.0851	-0.0234
Inverse Regression from X on Y	0.1968	-0.5092
Orthogonal Regression of Y and X	0.0852	-0.0236

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(8.51319765414882E-02) + (-2.33767473519939E-02) * (\text{Mercury})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	2.369967E-04	2.369967E-04	0.1444	0.7293	0.0588
Error	3	4.925295E-03	1.641765E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(1.641765E-03) = 0.0405187$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:00:15 PM

Database

Y = Mean_Growth X = Mercury

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9418	0.678542	Yes
Anderson Darling	0.2440	0.763919	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

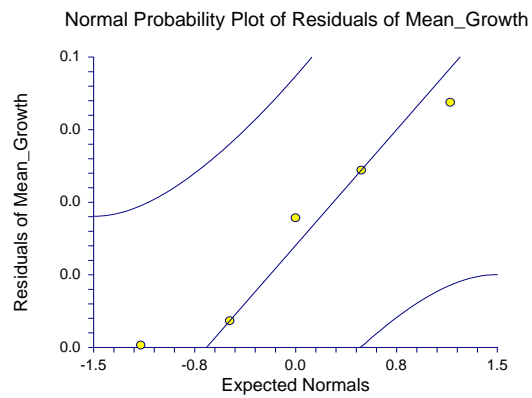
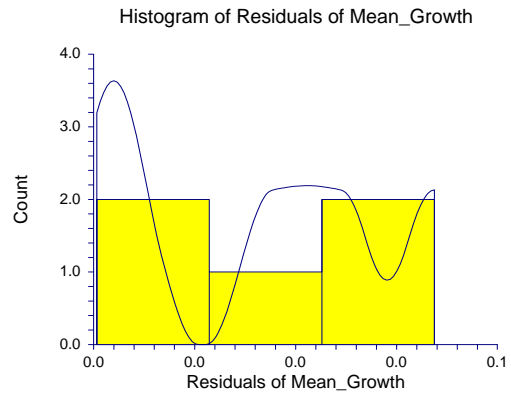
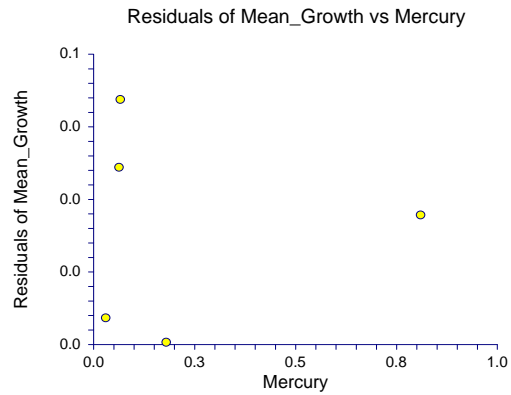
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 3:00:15 PM
Database
Y = Mean_Growth X = Mercury

Residual Plots Section



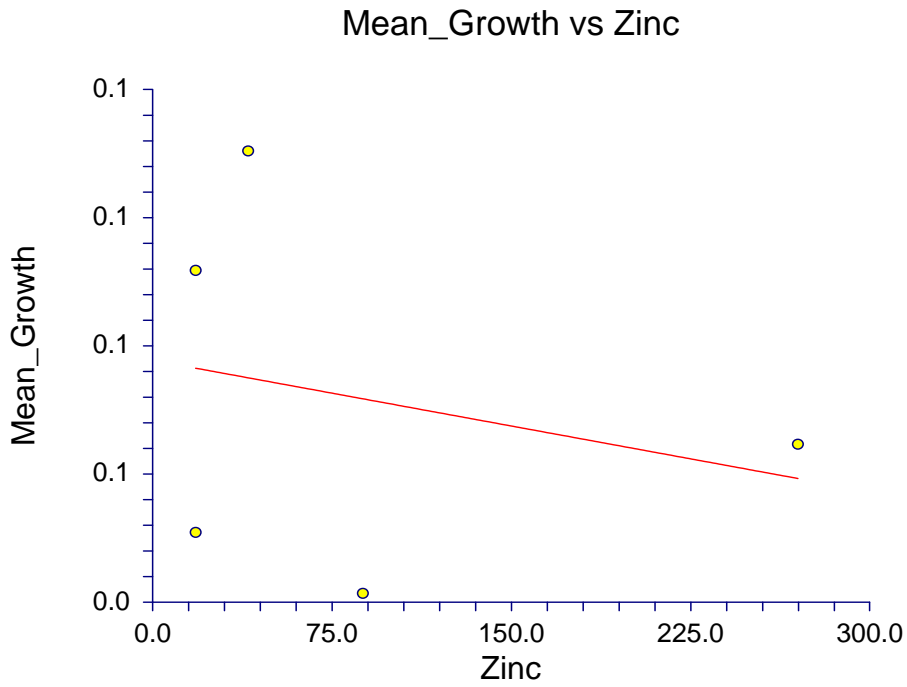
Linear Regression Report

Page/Date/Time 1 8/17/2009 3:00:32 PM

Database

Y = Mean_Growth X = Zinc

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	Zinc	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0872	Rows Prediction Only	5
Slope	-0.0001	Sum of Frequencies	5
R-Squared	0.0639	Sum of Weights	5.0000
Correlation	-0.2527	Coefficient of Variation	0.5032
Mean Square Error	1.610888E-03	Square Root of MSE	4.013586E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:00:32 PM
Y = Mean_Growth X = Zinc

Summary Statement

The equation of the straight line relating Mean_Growth and Zinc is estimated as: $\text{Mean_Growth} = (0.0872) + (-0.0001) \text{Zinc}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Zinc is zero, is 0.0872 with a standard error of 0.0243. The slope, the estimated change in Mean_Growth per unit change in Zinc, is -0.0001 with a standard error of 0.0002. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Zinc, is 0.0639. The correlation between Mean_Growth and Zinc is -0.2527.

A significance test that the slope is zero resulted in a t-value of -0.4524. The significance level of this t-test is 0.6817. Since $0.6817 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0001. The lower limit of the 95% confidence interval for the slope is -0.0007 and the upper limit is 0.0005. The estimated intercept is 0.0872. The lower limit of the 95% confidence interval for the intercept is 0.0098 and the upper limit is 0.1645.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Zinc
Count	5	5
Mean	0.0798	86.8000
Standard Deviation	0.0359	106.3259
Minimum	0.0417	18.0000
Maximum	0.1280	270.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:00:32 PM

Database

Y = Mean_Growth X = Zinc

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0872	-0.0001
Lower 95% Confidence Limit	0.0098	-0.0007
Upper 95% Confidence Limit	0.1645	0.0005
Standard Error	0.0243	0.0002
Standardized Coefficient	0.0000	-0.2527
T Value	3.5870	-0.4524
Prob Level (T Test)	0.0371	0.6817
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.6710	0.0625
Regression of Y on X	0.0872	-0.0001
Inverse Regression from X on Y	0.1958	-0.0013
Orthogonal Regression of Y and X	0.0872	-0.0001

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(8.71707692035524E-02) + (-8.53775253865478E-05) * (\text{Zinc})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	3.29629E-04	3.29629E-04	0.2046	0.6817	0.0625
Error	3	4.832663E-03	1.610888E-03			
Lack of Fit	2	3.527058E-03	1.763529E-03	1.3507	0.5198	
Pure Error	1	1.305605E-03	1.305605E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(1.610888E-03) = 4.013586E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:00:32 PM

Database

Y = Mean_Growth X = Zinc

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9280	0.582816	Yes
Anderson Darling	0.2774	0.653145	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(2, 1) Test	1.3507	0.519772	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

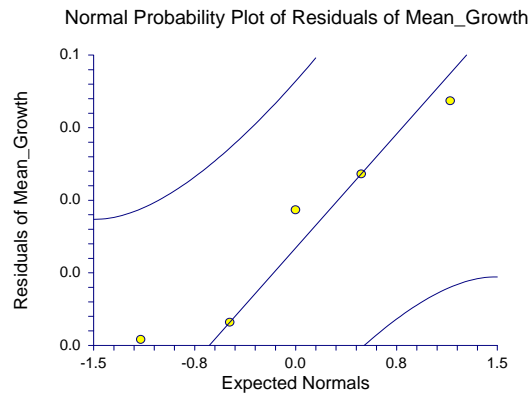
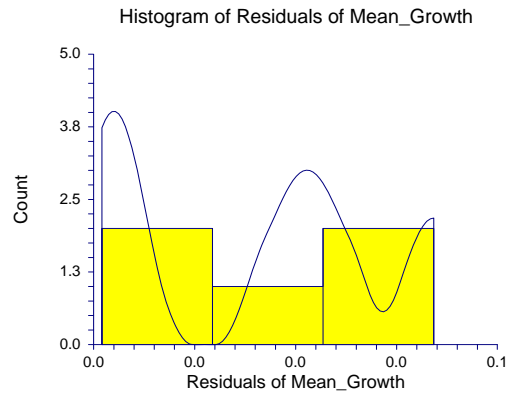
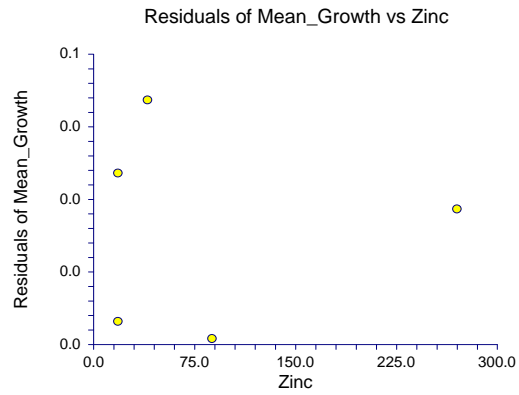
Linear Regression Report

Page/Date/Time 5 8/17/2009 3:00:32 PM

Database

Y = Mean_Growth X = Zinc

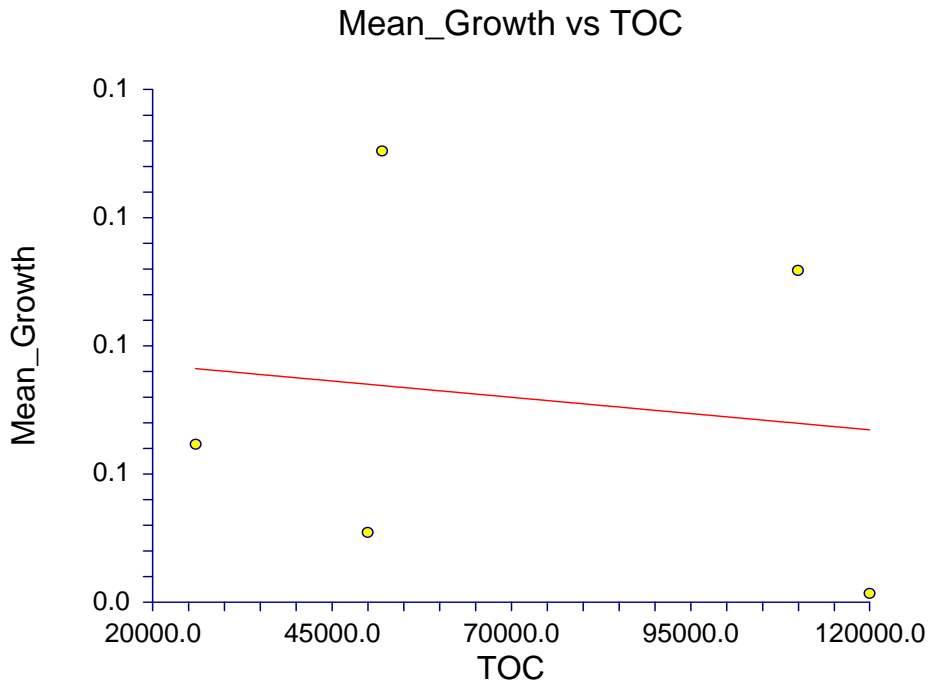
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 3:31:06 PM
Database
Y = Mean_Growth X = TOC

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	TOC	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0888	Rows Prediction Only	5
Slope	0.0000	Sum of Frequencies	5
R-Squared	0.0211	Sum of Weights	5.0000
Correlation	-0.1451	Coefficient of Variation	0.5146
Mean Square Error	1.684541E-03	Square Root of MSE	4.104316E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:31:06 PM
Y = Mean_Growth X = TOC

Summary Statement

The equation of the straight line relating Mean_Growth and TOC is estimated as: $\text{Mean_Growth} = (0.0888) + (0.0000) \text{ TOC}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when TOC is zero, is 0.0888 with a standard error of 0.0402. The slope, the estimated change in Mean_Growth per unit change in TOC, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in TOC, is 0.0211. The correlation between Mean_Growth and TOC is -0.1451.

A significance test that the slope is zero resulted in a t-value of -0.2540. The significance level of this t-test is 0.8159. Since $0.8159 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.0888. The lower limit of the 95% confidence interval for the intercept is -0.0391 and the upper limit is 0.2168.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	TOC
Count	5	5
Mean	0.0798	71600.0000
Standard Deviation	0.0359	41070.6708
Minimum	0.0417	26000.0000
Maximum	0.1280	120000.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:31:06 PM

Database

Y = Mean_Growth X = TOC

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0888	0.0000
Lower 95% Confidence Limit	-0.0391	0.0000
Upper 95% Confidence Limit	0.2168	0.0000
Standard Error	0.0402	0.0000
Standardized Coefficient	0.0000	-0.1451
T Value	2.2096	-0.2540
Prob Level (T Test)	0.1141	0.8159
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.3372	0.0539
Regression of Y on X	0.0888	0.0000
Inverse Regression from X on Y	0.5114	0.0000
Orthogonal Regression of Y and X	0.0889	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(8.88466801043396E-02) + (-1.26908940004742E-07) * (TOC)$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	1.086696E-04	1.086696E-04	0.0645	0.8159	0.0539
Error	3	5.053622E-03	1.684541E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(1.684541E-03) = 4.104316E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:31:06 PM

Database

Y = Mean_Growth X = TOC

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8566	0.216240	Yes
Anderson Darling	0.4323	0.304215	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

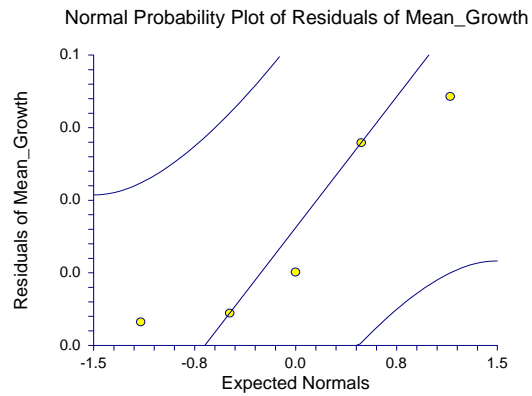
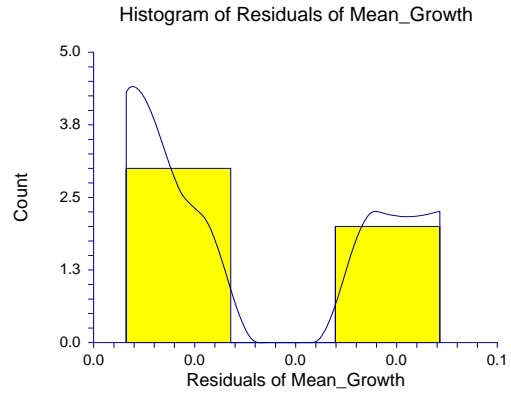
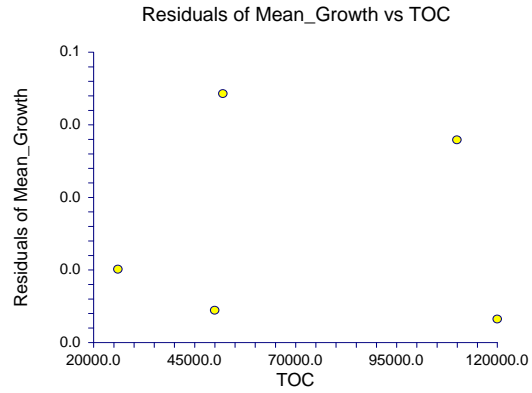
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 3:31:06 PM
Database
Y = Mean_Growth X = TOC

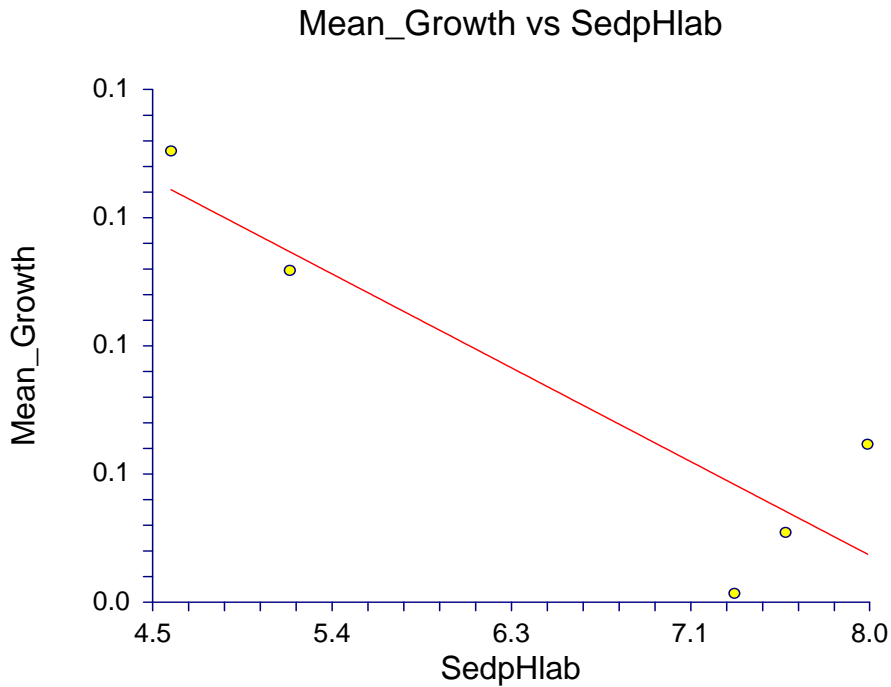
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 3:30:50 PM
Database
Y = Mean_Growth X = SedpHlab

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	SedpHlab	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.2164	Rows Prediction Only	5
Slope	-0.0209	Sum of Frequencies	5
R-Squared	0.8066	Sum of Weights	5.0000
Correlation	-0.8981	Coefficient of Variation	0.2287
Mean Square Error	3.327995E-04	Square Root of MSE	0.0182428

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:30:50 PM
Y = Mean_Growth X = SedpHlab

Summary Statement

The equation of the straight line relating Mean_Growth and SedpHlab is estimated as:
 $\text{Mean_Growth} = (0.2164) + (-0.0209) \text{ SedpHlab}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when SedpHlab is zero, is 0.2164 with a standard error of 0.0395. The slope, the estimated change in Mean_Growth per unit change in SedpHlab, is -0.0209 with a standard error of 0.0059. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in SedpHlab, is 0.8066. The correlation between Mean_Growth and SedpHlab is -0.8981.

A significance test that the slope is zero resulted in a t-value of -3.5372. The significance level of this t-test is 0.0384. Since $0.0384 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is -0.0209. The lower limit of the 95% confidence interval for the slope is -0.0397 and the upper limit is -0.0021. The estimated intercept is 0.2164. The lower limit of the 95% confidence interval for the intercept is 0.0908 and the upper limit is 0.3421.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	SedpHlab
Count	5	5
Mean	0.0798	6.5360
Standard Deviation	0.0359	1.5431
Minimum	0.0417	4.5900
Maximum	0.1280	7.9900

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:30:50 PM

Database

Y = Mean_Growth X = SedpHlab

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.2164	-0.0209
Lower 95% Confidence Limit	0.0908	-0.0397
Upper 95% Confidence Limit	0.3421	-0.0021
Standard Error	0.0395	0.0059
Standardized Coefficient	0.0000	-0.8981
T Value	5.4808	-3.5372
Prob Level (T Test)	0.0119	0.0384
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	0.9391	0.6600
Regression of Y on X	0.2164	-0.0209
Inverse Regression from X on Y	0.2492	-0.0259
Orthogonal Regression of Y and X	0.2164	-0.0209

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.216421082030005) + (-2.09089782787645E-02) * (SedpHlab)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	4.163893E-03	4.163893E-03	12.5117	0.0384	0.6600
Error	3	9.983986E-04	3.327995E-04			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(3.327995E-04) = 0.0182428$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:30:50 PM

Database

Y = Mean_Growth X = SedpHlab

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9745	0.903059	Yes
Anderson Darling	0.2276	0.813994	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

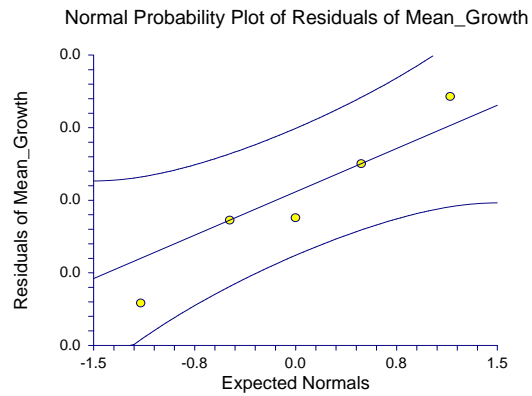
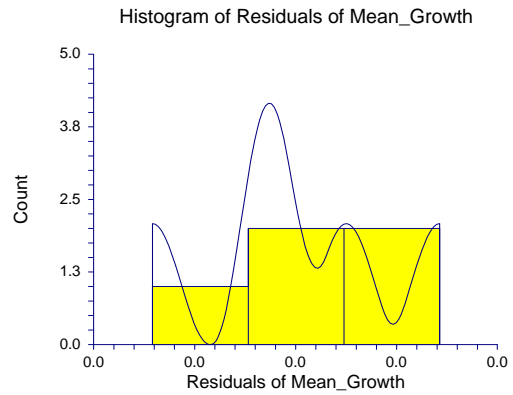
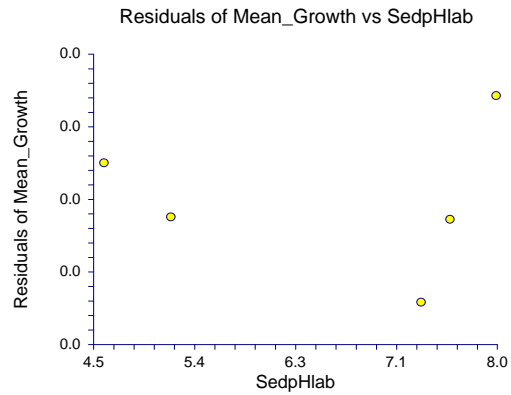
Linear Regression Report

Page/Date/Time 5 8/17/2009 3:30:50 PM

Database

Y = Mean_Growth X = SedpHlab

Residual Plots Section



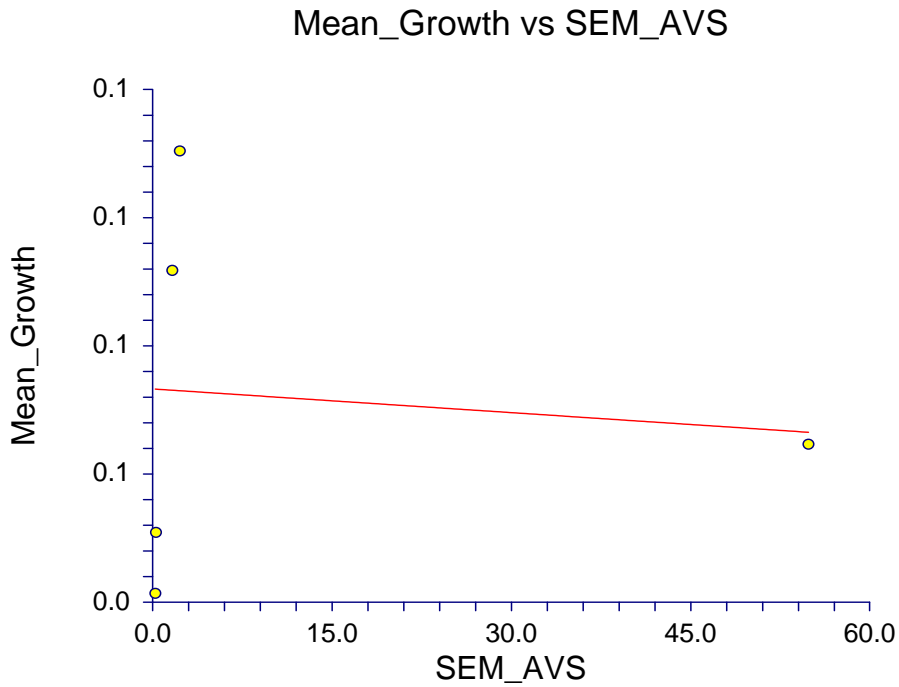
Linear Regression Report

Page/Date/Time 1 9/18/2009 9:38:05 AM

Database

Y = Mean_Growth X = SEM_AVS

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	SEM_AVS	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0816	Rows Prediction Only	5
Slope	-0.0002	Sum of Frequencies	5
R-Squared	0.0106	Sum of Weights	5.0000
Correlation	-0.1032	Coefficient of Variation	0.5173
Mean Square Error	1.702455E-03	Square Root of MSE	4.126082E-02

Linear Regression Report

Page/Date/Time 2 9/18/2009 9:38:05 AM
Y = Mean_Growth X = SEM_AVS

Summary Statement

The equation of the straight line relating Mean_Growth and SEM_AVS is estimated as: $\text{Mean_Growth} = (0.0816) + (-0.0002) \text{SEM_AVS}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when SEM_AVS is zero, is 0.0816 with a standard error of 0.0211. The slope, the estimated change in Mean_Growth per unit change in SEM_AVS, is -0.0002 with a standard error of 0.0009. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in SEM_AVS, is 0.0106. The correlation between Mean_Growth and SEM_AVS is -0.1032.

A significance test that the slope is zero resulted in a t-value of -0.1796. The significance level of this t-test is 0.8689. Since $0.8689 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0002. The lower limit of the 95% confidence interval for the slope is -0.0029 and the upper limit is 0.0026. The estimated intercept is 0.0816. The lower limit of the 95% confidence interval for the intercept is 0.0145 and the upper limit is 0.1486.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	SEM_AVS
Count	5	5
Mean	0.0798	11.8638
Standard Deviation	0.0359	24.0636
Minimum	0.0417	0.2260
Maximum	0.1280	54.8810

Linear Regression Report

Page/Date/Time 3 9/18/2009 9:38:05 AM

Database

Y = Mean_Growth X = SEM_AVS

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0816	-0.0002
Lower 95% Confidence Limit	0.0145	-0.0029
Upper 95% Confidence Limit	0.1486	0.0026
Standard Error	0.0211	0.0009
Standardized Coefficient	0.0000	-0.1032
T Value	3.8722	-0.1796
Prob Level (T Test)	0.0305	0.8689
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.7304	0.0520
Regression of Y on X	0.0816	-0.0002
Inverse Regression from X on Y	0.2515	-0.0145
Orthogonal Regression of Y and X	0.0816	-0.0002

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(8.15869537864529E-02) + (-1.53994240153885E-04) * (SEM_AVS)$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	5.492744E-05	5.492744E-05	0.0323	0.8689	0.0520
Error	3	5.107365E-03	1.702455E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(1.702455E-03) = 4.126082E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/18/2009 9:38:05 AM

Database

Y = Mean_Growth X = SEM_AVS

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9581	0.794725	Yes
Anderson Darling	0.2069	0.868603	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

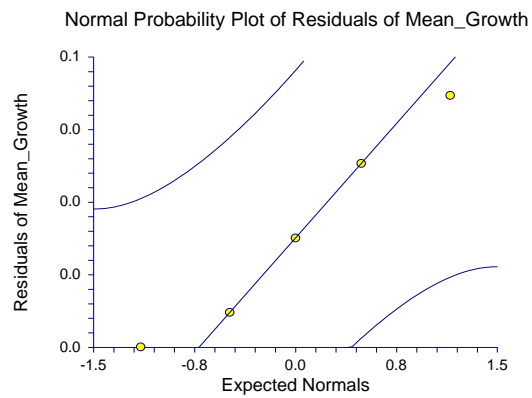
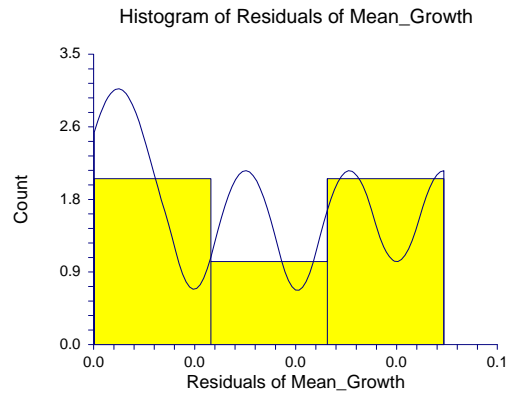
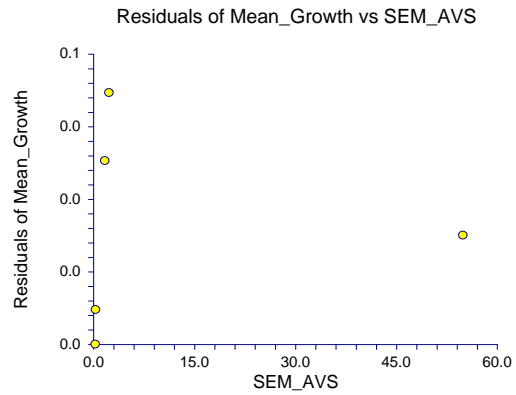
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 9/18/2009 9:38:05 AM
Database
Y = Mean_Growth X = SEM_AVS

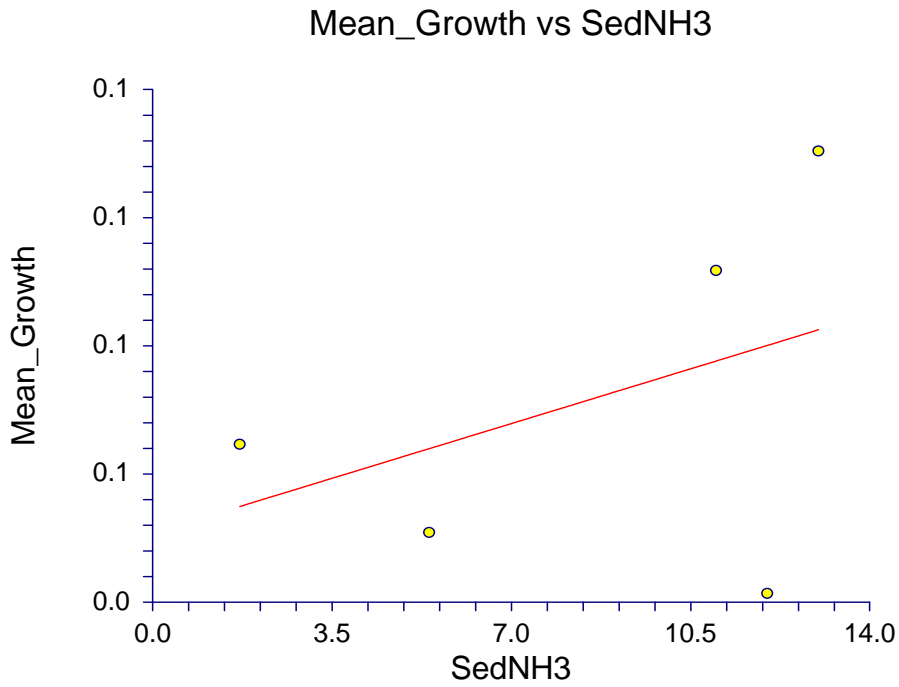
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 3:28:27 PM
Database
Y = Mean_Growth X = SedNH3

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	SedNH3	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0535	Rows Prediction Only	5
Slope	0.0030	Sum of Frequencies	5
R-Squared	0.1703	Sum of Weights	5.0000
Correlation	0.4126	Coefficient of Variation	0.4737
Mean Square Error	1.427783E-03	Square Root of MSE	3.778602E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:28:27 PM
Y = Mean_Growth X = SedNH3

Summary Statement

The equation of the straight line relating Mean_Growth and SedNH3 is estimated as: $\text{Mean_Growth} = (0.0535) + (0.0030) \text{SedNH3}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when SedNH3 is zero, is 0.0535 with a standard error of 0.0375. The slope, the estimated change in Mean_Growth per unit change in SedNH3, is 0.0030 with a standard error of 0.0039. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in SedNH3, is 0.1703. The correlation between Mean_Growth and SedNH3 is 0.4126.

A significance test that the slope is zero resulted in a t-value of 0.7846. The significance level of this t-test is 0.4899. Since $0.4899 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0030. The lower limit of the 95% confidence interval for the slope is -0.0093 and the upper limit is 0.0154. The estimated intercept is 0.0535. The lower limit of the 95% confidence interval for the intercept is -0.0659 and the upper limit is 0.1729.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	SedNH3
Count	5	5
Mean	0.0798	8.6200
Standard Deviation	0.0359	4.8613
Minimum	0.0417	1.7000
Maximum	0.1280	13.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:28:27 PM

Database

Y = Mean_Growth X = SedNH3

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0535	0.0030
Lower 95% Confidence Limit	-0.0659	-0.0093
Upper 95% Confidence Limit	0.1729	0.0154
Standard Error	0.0375	0.0039
Standardized Coefficient	0.0000	0.4126
T Value	1.4252	0.7846
Prob Level (T Test)	0.2493	0.4899
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.1740	0.0877
Regression of Y on X	0.0535	0.0030
Inverse Regression from X on Y	-0.0746	0.0179
Orthogonal Regression of Y and X	0.0535	0.0030

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(5.34750550101557E-02) + (3.04929756262694E-03) * (\text{SedNH3})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	8.789417E-04	8.789417E-04	0.6156	0.4899	0.0877
Error	3	4.28335E-03	1.427783E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(1.427783E-03) = 3.778602E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:28:27 PM

Database

Y = Mean_Growth X = SedNH3

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9427	0.684899	Yes
Anderson Darling	0.2696	0.679021	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

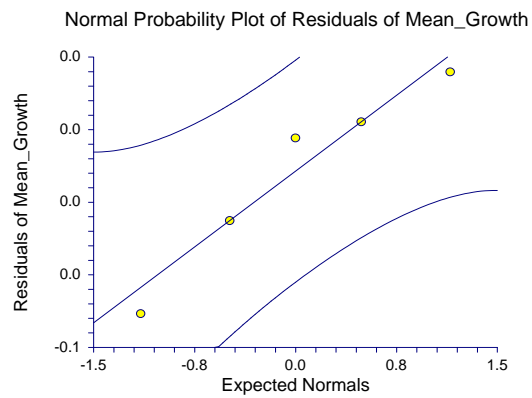
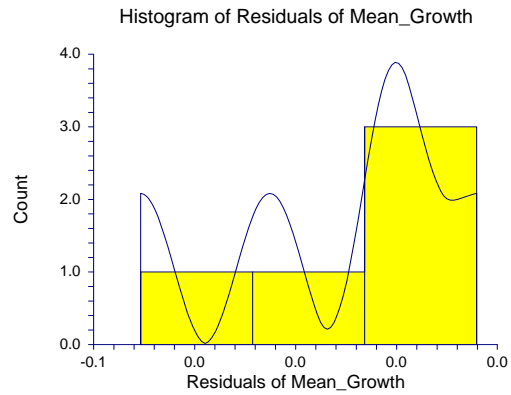
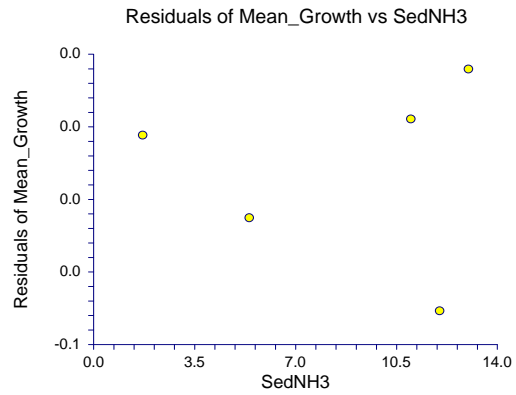
Linear Regression Report

Page/Date/Time 5 8/17/2009 3:28:27 PM

Database

Y = Mean_Growth X = SedNH3

Residual Plots Section



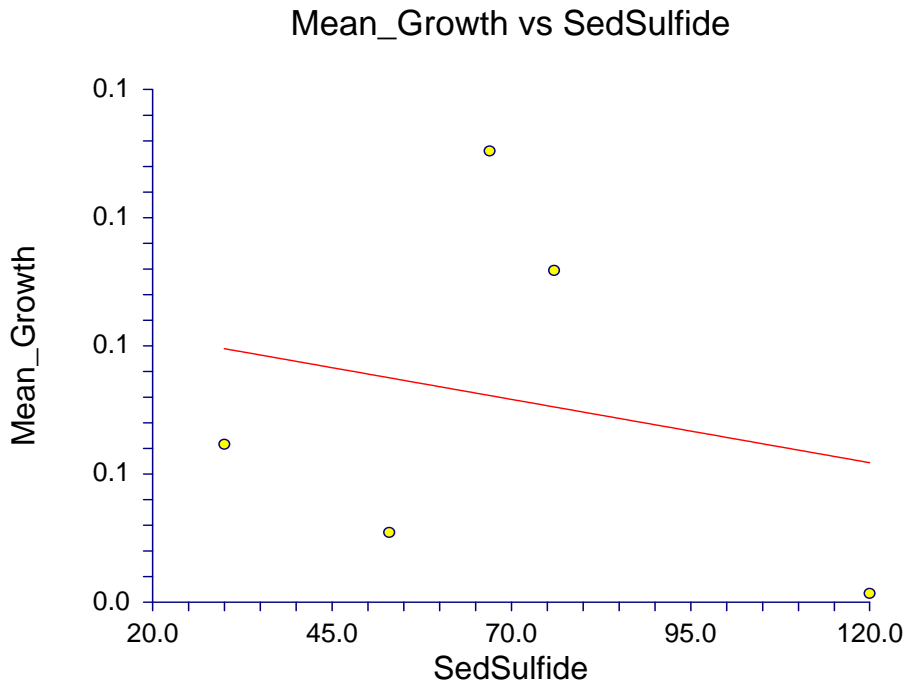
Linear Regression Report

Page/Date/Time 1 8/17/2009 3:30:31 PM

Database

Y = Mean_Growth X = SedSulfide

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	SedSulfide	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0969	Rows Prediction Only	5
Slope	-0.0002	Sum of Frequencies	5
R-Squared	0.0524	Sum of Weights	5.0000
Correlation	-0.2289	Coefficient of Variation	0.5063
Mean Square Error	1.630567E-03	Square Root of MSE	4.038028E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:30:31 PM
Y = Mean_Growth X = SedSulfide

Summary Statement

The equation of the straight line relating Mean_Growth and SedSulfide is estimated as:
 $\text{Mean_Growth} = (0.0969) + (-0.0002) \text{ SedSulfide}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when SedSulfide is zero, is 0.0969 with a standard error of 0.0457. The slope, the estimated change in Mean_Growth per unit change in SedSulfide, is -0.0002 with a standard error of 0.0006. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in SedSulfide, is 0.0524. The correlation between Mean_Growth and SedSulfide is -0.2289.

A significance test that the slope is zero resulted in a t-value of -0.4074. The significance level of this t-test is 0.7111. Since $0.7111 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0002. The lower limit of the 95% confidence interval for the slope is -0.0022 and the upper limit is 0.0017. The estimated intercept is 0.0969. The lower limit of the 95% confidence interval for the intercept is -0.0486 and the upper limit is 0.2423.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	SedSulfide
Count	5	5
Mean	0.0798	69.2000
Standard Deviation	0.0359	33.2821
Minimum	0.0417	30.0000
Maximum	0.1280	120.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:30:31 PM

Database

Y = Mean_Growth X = SedSulfide

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0969	-0.0002
Lower 95% Confidence Limit	-0.0486	-0.0022
Upper 95% Confidence Limit	0.2423	0.0017
Standard Error	0.0457	0.0006
Standardized Coefficient	0.0000	-0.2289
T Value	2.1196	-0.4074
Prob Level (T Test)	0.1242	0.7111
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.3160	0.0601
Regression of Y on X	0.0969	-0.0002
Inverse Regression from X on Y	0.4060	-0.0047
Orthogonal Regression of Y and X	0.0969	-0.0002

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(9.68610273539767E-02) + (-2.47124672745328E-04) * (\text{SedSulfide})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	2.705916E-04	2.705916E-04	0.1659	0.7111	0.0601
Error	3	4.891701E-03	1.630567E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(1.630567E-03) = 4.038028E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:30:31 PM

Database

Y = Mean_Growth X = SedSulfide

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8460	0.182176	No
Anderson Darling	0.4733	0.242462	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

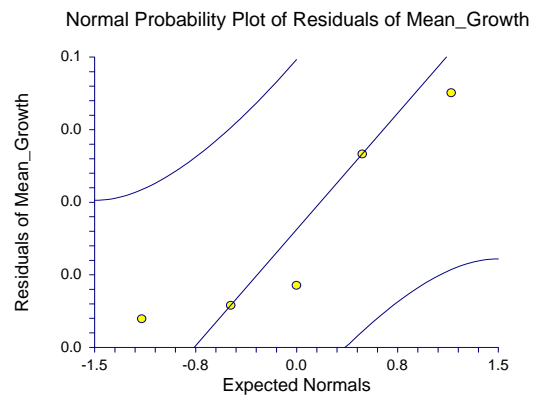
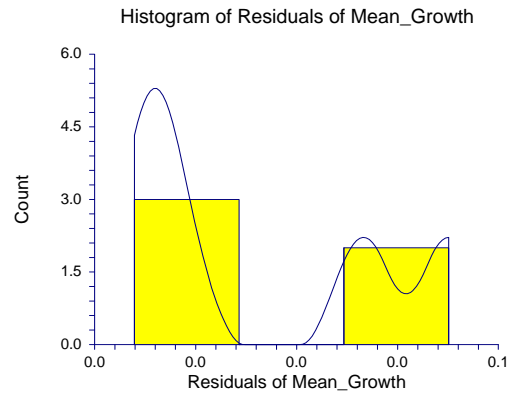
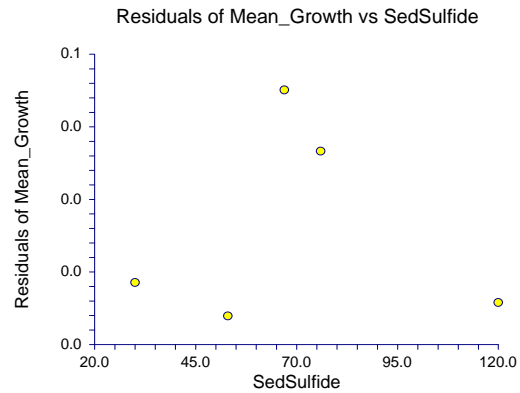
Linear Regression Report

Page/Date/Time 5 8/17/2009 3:30:31 PM

Database

Y = Mean_Growth X = SedSulfide

Residual Plots Section



Linear Regression Report

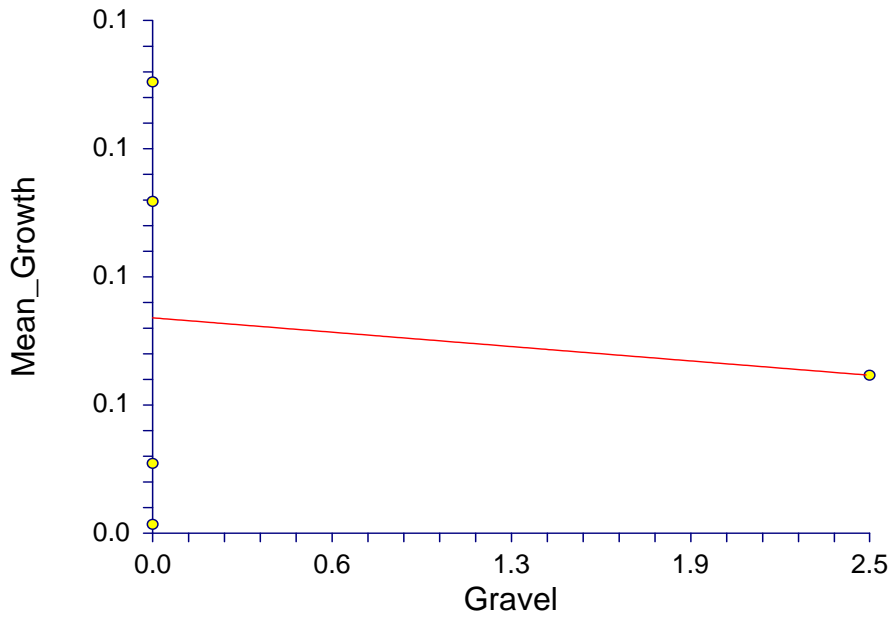
Page/Date/Time 1 8/17/2009 3:31:24 PM

Database

Y = Mean_Growth X = Gravel

Linear Regression Plot Section

Mean_Growth vs Gravel



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	Gravel	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0820	Rows Prediction Only	5
Slope	-0.0045	Sum of Frequencies	5
R-Squared	0.0194	Sum of Weights	5.0000
Correlation	-0.1394	Coefficient of Variation	0.5150
Mean Square Error	1.687313E-03	Square Root of MSE	4.107692E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:31:24 PM
Y = Mean_Growth X = Gravel

Summary Statement

The equation of the straight line relating Mean_Growth and Gravel is estimated as: $\text{Mean_Growth} = (0.0820) + (-0.0045) \text{Gravel}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Gravel is zero, is 0.0820 with a standard error of 0.0205. The slope, the estimated change in Mean_Growth per unit change in Gravel, is -0.0045 with a standard error of 0.0184. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Gravel, is 0.0194. The correlation between Mean_Growth and Gravel is -0.1394.

A significance test that the slope is zero resulted in a t-value of -0.2439. The significance level of this t-test is 0.8231. Since $0.8231 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0045. The lower limit of the 95% confidence interval for the slope is -0.0629 and the upper limit is 0.0540. The estimated intercept is 0.0820. The lower limit of the 95% confidence interval for the intercept is 0.0166 and the upper limit is 0.1474.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Gravel
Count	5	5
Mean	0.0798	0.5000
Standard Deviation	0.0359	1.1180
Minimum	0.0417	0.0000
Maximum	0.1280	2.5000

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:31:24 PM

Database

Y = Mean_Growth X = Gravel

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0820	-0.0045
Lower 95% Confidence Limit	0.0166	-0.0629
Upper 95% Confidence Limit	0.1474	0.0540
Standard Error	0.0205	0.0184
Standardized Coefficient	0.0000	-0.1394
T Value	3.9925	-0.2439
Prob Level (T Test)	0.0281	0.8231
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.7536	0.0536
Regression of Y on X	0.0820	-0.0045
Inverse Regression from X on Y	0.1950	-0.2305
Orthogonal Regression of Y and X	0.0820	-0.0045

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.082) + (-.00448) * (Gravel)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	1.00352E-04	1.00352E-04	0.0595	0.8231	0.0536
Error	3	5.06194E-03	1.687313E-03			
Lack of Fit	0	0	0	0.0000	0.0000	
Pure Error	3	5.06194E-03	0			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

s = Square Root(1.687313E-03) = 4.107692E-02

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:31:24 PM

Database

Y = Mean_Growth X = Gravel

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9595	0.804531	Yes
Anderson Darling	0.2044	0.874406	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 3) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

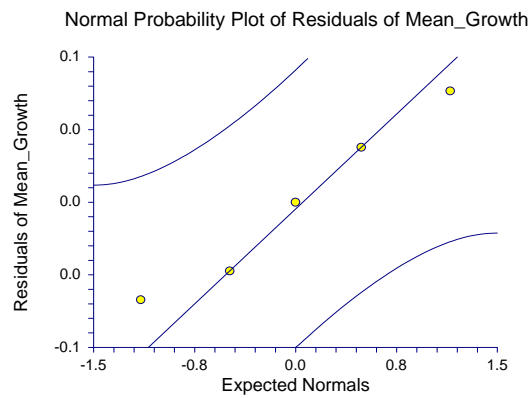
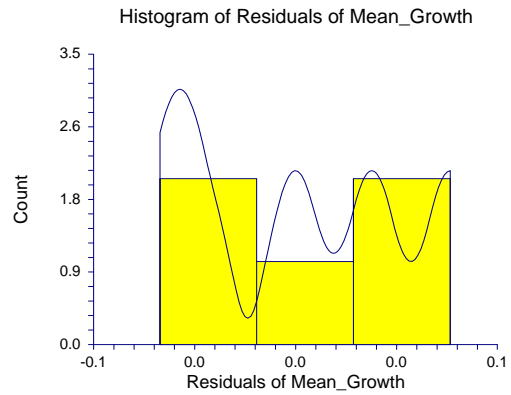
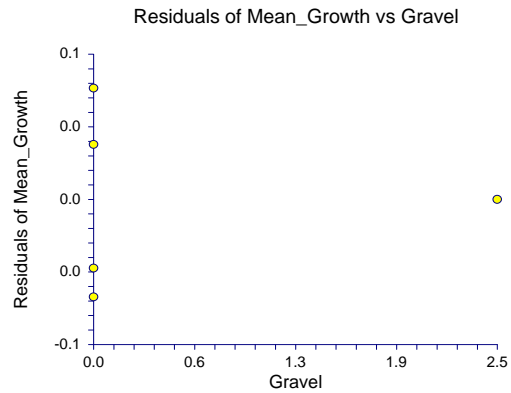
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 3:31:24 PM
Database
Y = Mean_Growth X = Gravel

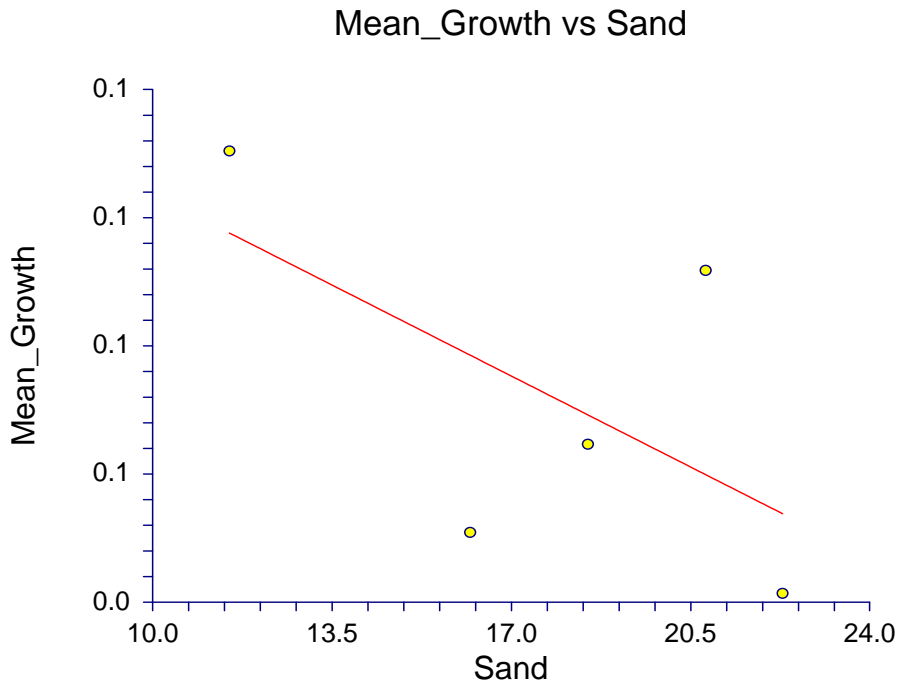
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 3:31:38 PM
Database
Y = Mean_Growth X = Sand

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	Sand	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1703	Rows Prediction Only	5
Slope	-0.0051	Sum of Frequencies	5
R-Squared	0.3581	Sum of Weights	5.0000
Correlation	-0.5984	Coefficient of Variation	0.4167
Mean Square Error	1.104492E-03	Square Root of MSE	0.0332339

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:31:38 PM
Y = Mean_Growth X = Sand

Summary Statement

The equation of the straight line relating Mean_Growth and Sand is estimated as: $\text{Mean_Growth} = (0.1703) + (-0.0051) \text{ Sand}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Sand is zero, is 0.1703 with a standard error of 0.0715. The slope, the estimated change in Mean_Growth per unit change in Sand, is -0.0051 with a standard error of 0.0039. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Sand, is 0.3581. The correlation between Mean_Growth and Sand is -0.5984.

A significance test that the slope is zero resulted in a t-value of -1.2938. The significance level of this t-test is 0.2863. Since $0.2863 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0051. The lower limit of the 95% confidence interval for the slope is -0.0175 and the upper limit is 0.0074. The estimated intercept is 0.1703. The lower limit of the 95% confidence interval for the intercept is -0.0573 and the upper limit is 0.3979.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Sand
Count	5	5
Mean	0.0798	17.8600
Standard Deviation	0.0359	4.2418
Minimum	0.0417	11.5000
Maximum	0.1280	22.3000

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:31:38 PM

Database

Y = Mean_Growth X = Sand

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1703	-0.0051
Lower 95% Confidence Limit	-0.0573	-0.0175
Upper 95% Confidence Limit	0.3979	0.0074
Standard Error	0.0715	0.0039
Standardized Coefficient	0.0000	-0.5984
T Value	2.3807	-1.2938
Prob Level (T Test)	0.0976	0.2863
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.3784	0.1524
Regression of Y on X	0.1703	-0.0051
Inverse Regression from X on Y	0.3325	-0.0142
Orthogonal Regression of Y and X	0.1703	-0.0051

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.170280411826821) + (-5.06833212916133E-03) * (Sand)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	1.848816E-03	1.848816E-03	1.6739	0.2863	0.1524
Error	3	3.313476E-03	1.104492E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

s = Square Root(1.104492E-03) = 0.0332339

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:31:38 PM

Database

Y = Mean_Growth X = Sand

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9832	0.950857	Yes
Anderson Darling	0.1762	0.922734	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

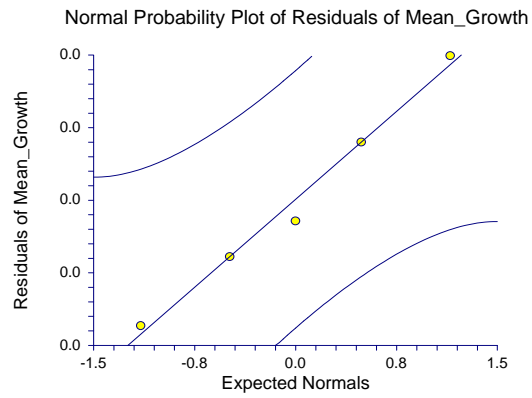
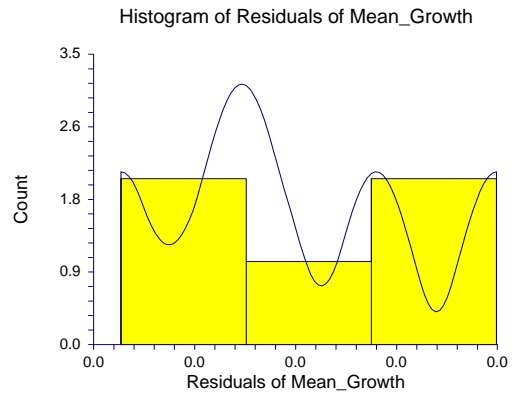
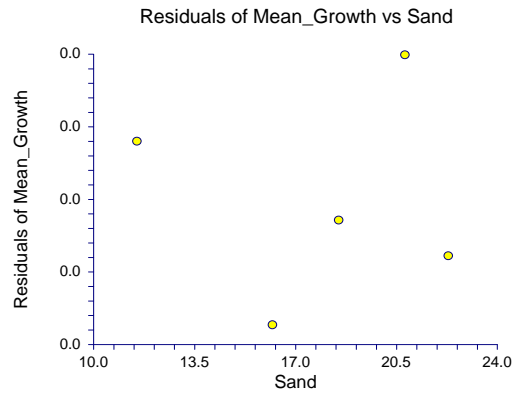
Linear Regression Report

Page/Date/Time 5 8/17/2009 3:31:38 PM

Database

Y = Mean_Growth X = Sand

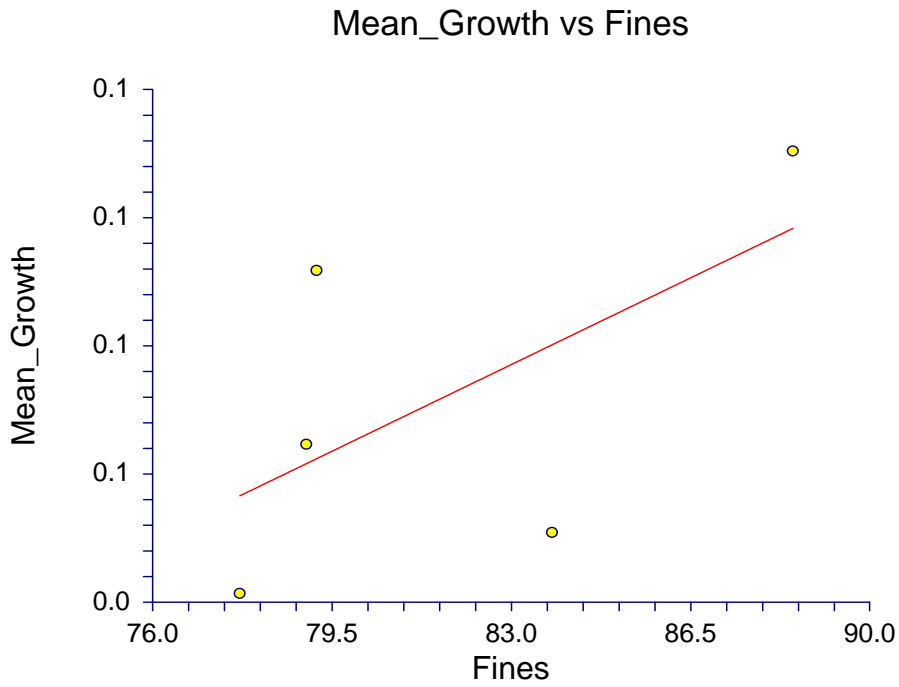
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 3:32:02 PM
Database
Y = Mean_Growth X = Fines

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	Fines	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	-0.3145	Rows Prediction Only	5
Slope	0.0048	Sum of Frequencies	5
R-Squared	0.3622	Sum of Weights	5.0000
Correlation	0.6018	Coefficient of Variation	0.4154
Mean Square Error	1.097492E-03	Square Root of MSE	3.312842E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:32:02 PM
Y = Mean_Growth X = Fines

Summary Statement

The equation of the straight line relating Mean_Growth and Fines is estimated as: $\text{Mean_Growth} = (-0.3145) + (0.0048) \text{ Fines}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when Fines is zero, is -0.3145 with a standard error of 0.3024. The slope, the estimated change in Mean_Growth per unit change in Fines, is 0.0048 with a standard error of 0.0037. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in Fines, is 0.3622. The correlation between Mean_Growth and Fines is 0.6018.

A significance test that the slope is zero resulted in a t-value of 1.3053. The significance level of this t-test is 0.2829. Since $0.2829 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0048. The lower limit of the 95% confidence interval for the slope is -0.0069 and the upper limit is 0.0166. The estimated intercept is -0.3145. The lower limit of the 95% confidence interval for the intercept is -1.2770 and the upper limit is 0.6479.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	Fines
Count	5	5
Mean	0.0798	81.6400
Standard Deviation	0.0359	4.4769
Minimum	0.0417	77.7000
Maximum	0.1280	88.5000

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:32:02 PM

Database

Y = Mean_Growth X = Fines

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-0.3145	0.0048
Lower 95% Confidence Limit	-1.2770	-0.0069
Upper 95% Confidence Limit	0.6479	0.0166
Standard Error	0.3024	0.0037
Standardized Coefficient	0.0000	0.6018
T Value	-1.0400	1.3053
Prob Level (T Test)	0.3748	0.2829
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.1163	0.1542
Regression of Y on X	-0.3145	0.0048
Inverse Regression from X on Y	-1.0088	0.0133
Orthogonal Regression of Y and X	-0.3145	0.0048

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(-.314507473931059) + (4.82934191488312E-03) * (\text{Fines})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	1.869815E-03	1.869815E-03	1.7037	0.2829	0.1542
Error	3	3.292477E-03	1.097492E-03			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(1.097492E-03) = 3.312842E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:32:02 PM

Database

Y = Mean_Growth X = Fines

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9857	0.962656	Yes
Anderson Darling	0.1659	0.940086	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable.

This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

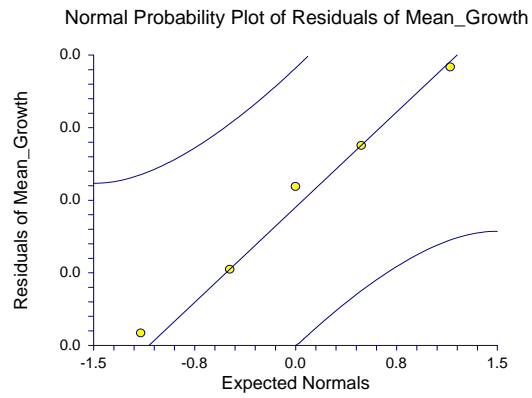
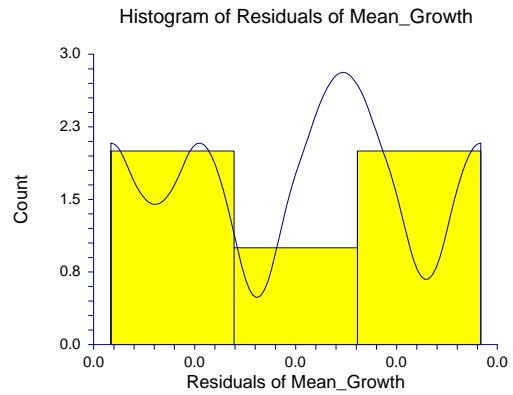
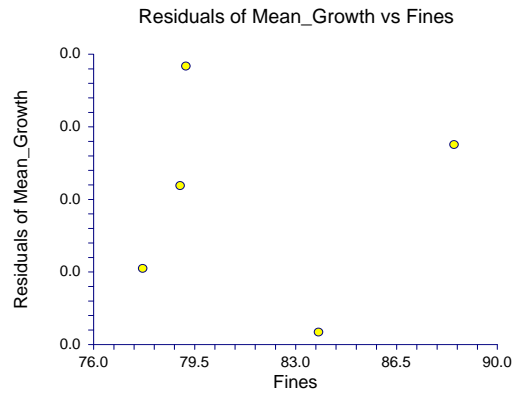
Linear Regression Report

Page/Date/Time 5 8/17/2009 3:32:02 PM

Database

Y = Mean_Growth X = Fines

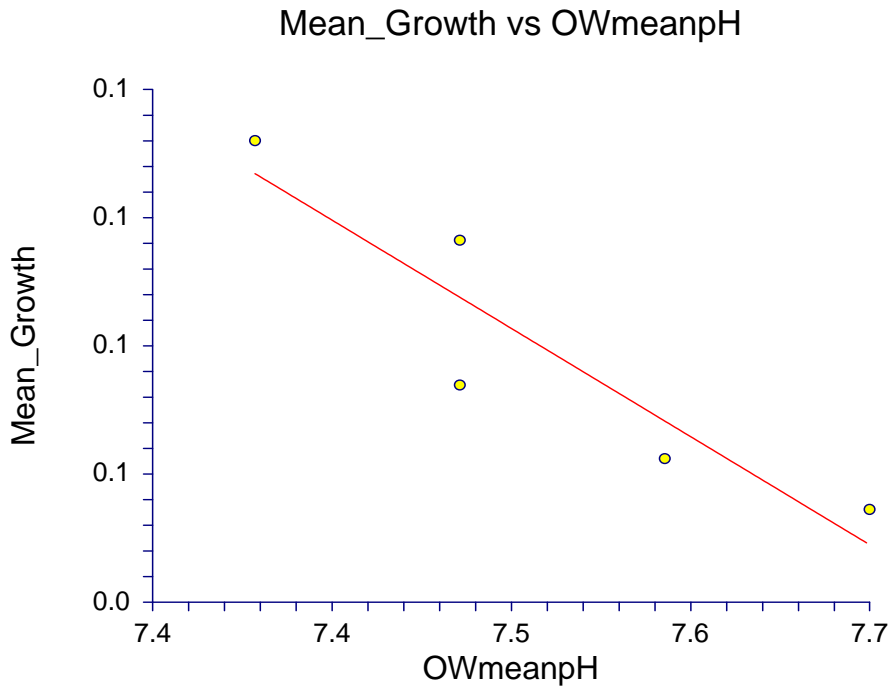
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 9/18/2009 9:33:28 AM
Database
Y = Mean_Growth X = OWmeanpH

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	OWmeanpH	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	2.2623	Rows Prediction Only	5
Slope	-0.2895	Sum of Frequencies	5
R-Squared	0.8440	Sum of Weights	5.0000
Correlation	-0.9187	Coefficient of Variation	0.2054
Mean Square Error	2.68439E-04	Square Root of MSE	1.638411E-02

Linear Regression Report

Page/Date/Time 2 9/18/2009 9:33:28 AM
Y = Mean_Growth X = OWmeanpH

Summary Statement

The equation of the straight line relating Mean_Growth and OWmeanpH is estimated as:
 $\text{Mean_Growth} = (2.2623) + (-0.2895) \text{ OWmeanpH}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when OWmeanpH is zero, is 2.2623 with a standard error of 0.5418. The slope, the estimated change in Mean_Growth per unit change in OWmeanpH, is -0.2895 with a standard error of 0.0718. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in OWmeanpH, is 0.8440. The correlation between Mean_Growth and OWmeanpH is -0.9187.

A significance test that the slope is zero resulted in a t-value of -4.0287. The significance level of this t-test is 0.0275. Since $0.0275 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is -0.2895. The lower limit of the 95% confidence interval for the slope is -0.5181 and the upper limit is -0.0608. The estimated intercept is 2.2623. The lower limit of the 95% confidence interval for the intercept is 0.5381 and the upper limit is 3.9865.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	OWmeanpH
Count	5	5
Mean	0.0798	7.5400
Standard Deviation	0.0359	0.1140
Minimum	0.0417	7.4000
Maximum	0.1280	7.7000

Linear Regression Report

Page/Date/Time 3 9/18/2009 9:33:28 AM

Database

Y = Mean_Growth X = OWmeanpH

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	2.2623	-0.2895
Lower 95% Confidence Limit	0.5381	-0.5181
Upper 95% Confidence Limit	3.9865	-0.0608
Standard Error	0.5418	0.0718
Standardized Coefficient	0.0000	-0.9187
T Value	4.1756	-4.0287
Prob Level (T Test)	0.0250	0.0275
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	0.7865	0.7603
Regression of Y on X	2.2623	-0.2895
Inverse Regression from X on Y	2.6657	-0.3430
Orthogonal Regression of Y and X	2.2939	-0.2937

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(2.26230000000175) + (-.28946153846176) * (OWmeanpH)$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	4.356975E-03	4.356975E-03	16.2308	0.0275	0.7603
Error	3	8.053169E-04	2.68439E-04			
Lack of Fit	2	2.307119E-04	1.15356E-04	0.2008	0.8447	
Pure Error	1	5.74605E-04	5.74605E-04			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(2.68439E-04) = 1.638411E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/18/2009 9:33:28 AM

Database

Y = Mean_Growth X = OWmeanpH

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8816	0.316721	Yes
Anderson Darling	0.4103	0.342913	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(2, 1) Test	0.2008	0.844698	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

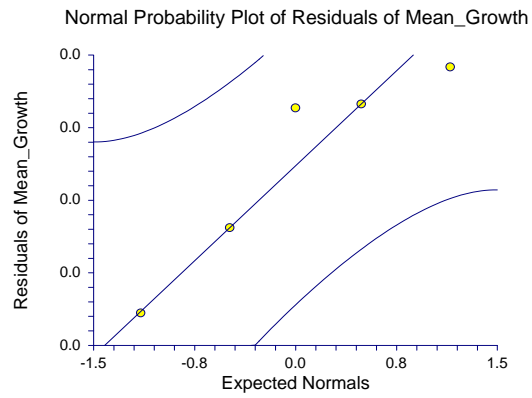
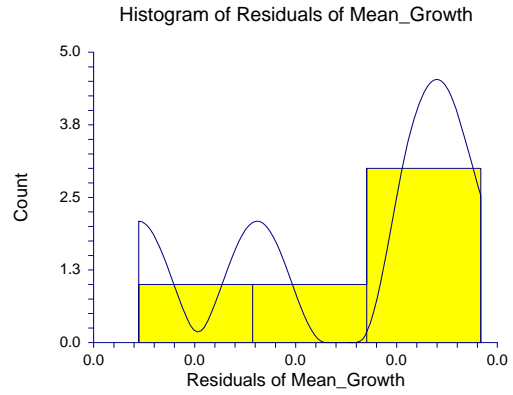
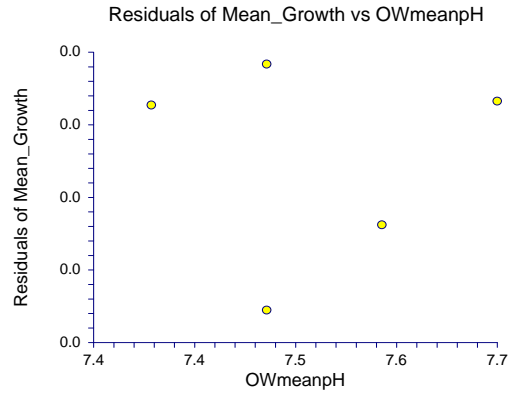
Linear Regression Report

Page/Date/Time 5 9/18/2009 9:33:28 AM

Database

Y = Mean_Growth X = OWmeanpH

Residual Plots Section



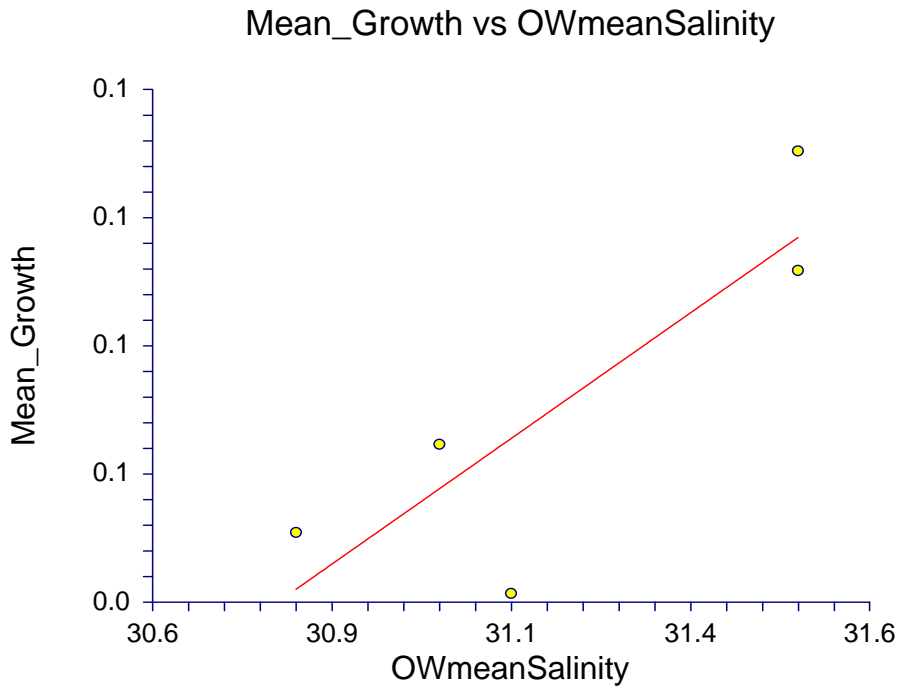
Linear Regression Report

Page/Date/Time 1 9/18/2009 9:34:29 AM

Database

Y = Mean_Growth X = OWmeanSalinity

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	OWmeanSalinity	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	-2.9752	Rows Prediction Only	5
Slope	0.0980	Sum of Frequencies	5
R-Squared	0.7215	Sum of Weights	5.0000
Correlation	0.8494	Coefficient of Variation	0.2744
Mean Square Error	4.791693E-04	Square Root of MSE	2.188994E-02

Linear Regression Report

Page/Date/Time 2 9/18/2009 9:34:29 AM
Y = Mean_Growth X = OWmeanSalinity

Summary Statement

The equation of the straight line relating Mean_Growth and OWmeanSalinity is estimated as:
 $\text{Mean_Growth} = (-2.9752) + (0.0980) \text{ OWmeanSalinity}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when OWmeanSalinity is zero, is -2.9752 with a standard error of 1.0958. The slope, the estimated change in Mean_Growth per unit change in OWmeanSalinity, is 0.0980 with a standard error of 0.0351. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in OWmeanSalinity, is 0.7215. The correlation between Mean_Growth and OWmeanSalinity is 0.8494.

A significance test that the slope is zero resulted in a t-value of 2.7881. The significance level of this t-test is 0.0685. Since $0.0685 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0980. The lower limit of the 95% confidence interval for the slope is -0.0139 and the upper limit is 0.2098. The estimated intercept is -2.9752. The lower limit of the 95% confidence interval for the intercept is -6.4625 and the upper limit is 0.5120.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	OWmeanSalinity
Count	5	5
Mean	0.0798	31.1800
Standard Deviation	0.0359	0.3114
Minimum	0.0417	30.8000
Maximum	0.1280	31.5000

Linear Regression Report

Page/Date/Time 3 9/18/2009 9:34:29 AM

Database

Y = Mean_Growth X = OWmeanSalinity

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-2.9752	0.0980
Lower 95% Confidence Limit	-6.4625	-0.0139
Upper 95% Confidence Limit	0.5120	0.2098
Standard Error	1.0958	0.0351
Standardized Coefficient	0.0000	0.8494
T Value	-2.7152	2.7881
Prob Level (T Test)	0.0728	0.0685
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.4616	0.4799
Regression of Y on X	-2.9752	0.0980
Inverse Regression from X on Y	-4.1543	0.1358
Orthogonal Regression of Y and X	-2.9865	0.0983

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(-2.97523711340205) + (9.79793814433039E-02) * (OWmeanSalinity)$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	3.724784E-03	3.724784E-03	7.7734	0.0685	0.4799
Error	3	1.437508E-03	4.791693E-04			
Lack of Fit	2	1.166063E-03	5.830314E-04	2.1479	0.4345	
Pure Error	1	2.71445E-04	2.71445E-04			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(4.791693E-04) = 2.188994E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/18/2009 9:34:29 AM

Database

Y = Mean_Growth X = OWmeanSalinity

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8782	0.301182	Yes
Anderson Darling	0.4072	0.348790	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(2, 1) Test	2.1479	0.434546	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

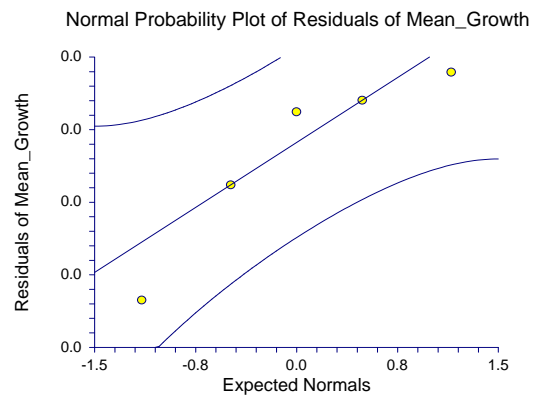
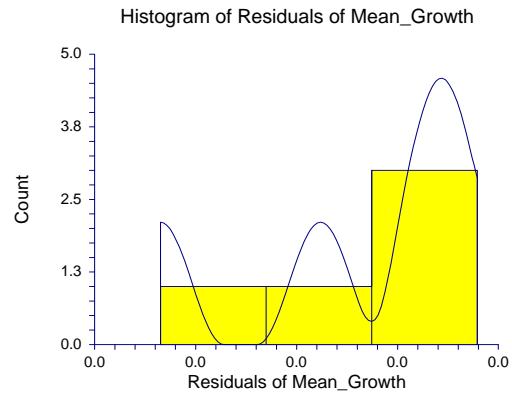
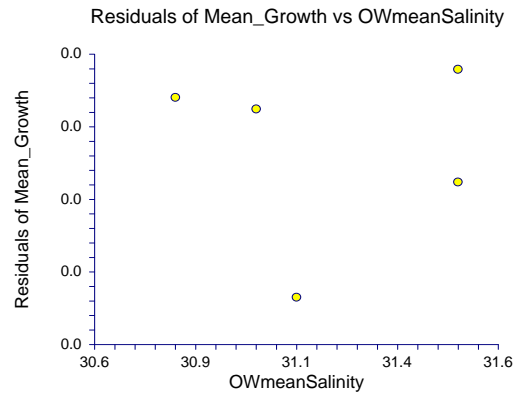
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 9/18/2009 9:34:29 AM
Database
Y = Mean_Growth X = OWmeanSalinity

Residual Plots Section



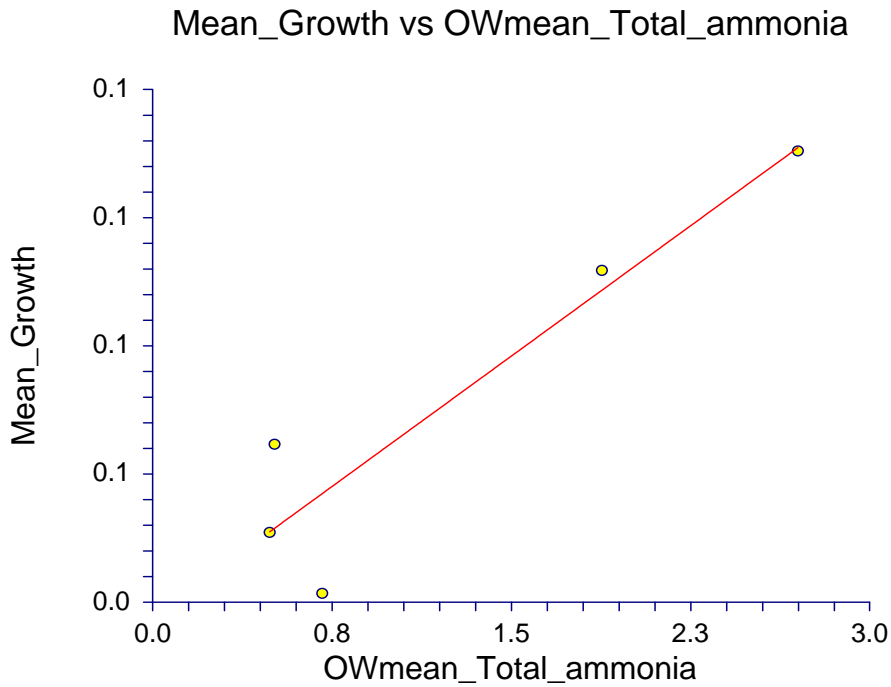
Linear Regression Report

Page/Date/Time 1 9/18/2009 9:34:53 AM

Database

Y = Mean_Growth X = OWmean_Total_ammonia

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	OWmean_Total_ammonia	Rows Used in Estimation	5
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0371	Rows Prediction Only	5
Slope	0.0339	Sum of Frequencies	5
R-Squared	0.8714	Sum of Weights	5.0000
Correlation	0.9335	Coefficient of Variation	0.1865
Mean Square Error	2.212441E-04	Square Root of MSE	1.487428E-02

Linear Regression Report

Page/Date/Time 2 9/18/2009 9:34:53 AM

Y = Mean_Growth X = OWmean_Total_ammonia

Summary Statement

The equation of the straight line relating Mean_Growth and OWmean_Total_ammonia is estimated as: $\text{Mean_Growth} = (0.0371) + (0.0339) \text{OWmean_Total_ammonia}$ using the 5 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when OWmean_Total_ammonia is zero, is 0.0371 with a standard error of 0.0116. The slope, the estimated change in Mean_Growth per unit change in OWmean_Total_ammonia, is 0.0339 with a standard error of 0.0075. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in OWmean_Total_ammonia, is 0.8714. The correlation between Mean_Growth and OWmean_Total_ammonia is 0.9335.

A significance test that the slope is zero resulted in a t-value of 4.5092. The significance level of this t-test is 0.0204. Since $0.0204 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is 0.0339. The lower limit of the 95% confidence interval for the slope is 0.0100 and the upper limit is 0.0578. The estimated intercept is 0.0371. The lower limit of the 95% confidence interval for the intercept is 0.0003 and the upper limit is 0.0739.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	OWmean_Total_ammonia
Count	5	5
Mean	0.0798	1.2580
Standard Deviation	0.0359	0.9894
Minimum	0.0417	0.4900
Maximum	0.1280	2.7000

Linear Regression Report

Page/Date/Time 3 9/18/2009 9:34:53 AM

Database

Y = Mean_Growth X = OWmean_Total_ammonia

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0371	0.0339
Lower 95% Confidence Limit	0.0003	0.0100
Upper 95% Confidence Limit	0.0739	0.0578
Standard Error	0.0116	0.0075
Standardized Coefficient	0.0000	0.9335
T Value	3.2108	4.5092
Prob Level (T Test)	0.0489	0.0204
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	0.5843	0.8389
Regression of Y on X	0.0371	0.0339
Inverse Regression from X on Y	0.0308	0.0389
Orthogonal Regression of Y and X	0.0371	0.0339

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(3.71214240477236E-02) + (3.38939395487094E-02) * (OWmean_Total_ammonia)$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.180829E-02	3.180829E-02			
Slope	1	4.49856E-03	4.49856E-03	20.3330	0.0204	0.8389
Error	3	6.637324E-04	2.212441E-04			
Adj. Total	4	5.162292E-03	1.290573E-03			
Total	5	3.697058E-02				

$s = \text{Square Root}(2.212441E-04) = 1.487428E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/18/2009 9:34:53 AM

Database

Y = Mean_Growth X = OWmean_Total_ammonia

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9364	0.640930	Yes
Anderson Darling	0.3398	0.501729	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			

Constant Residual Variance?

Modified Levene Test

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

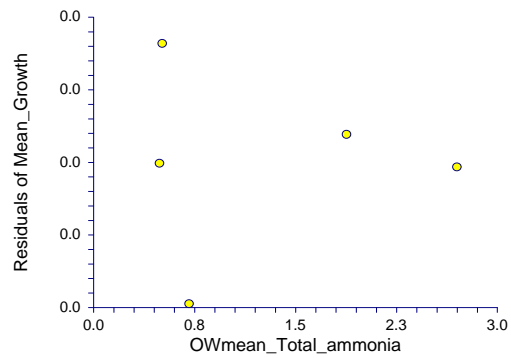
Page/Date/Time 5 9/18/2009 9:34:53 AM

Database

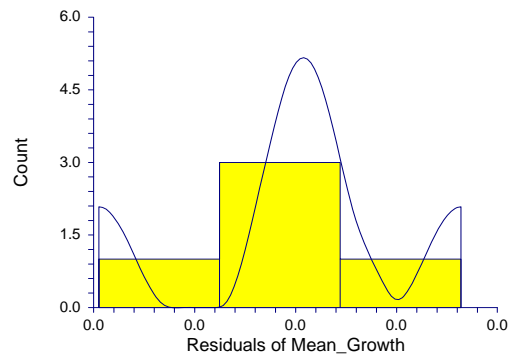
Y = Mean_Growth X = OWmean_Total_ammonia

Residual Plots Section

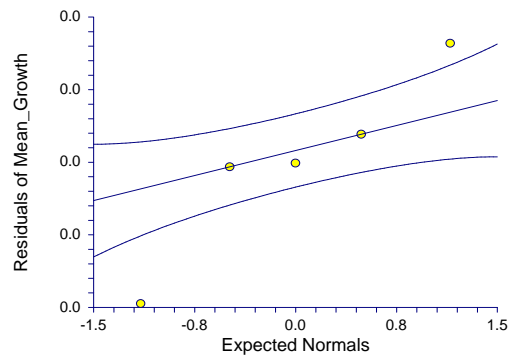
Residuals of Mean_Growth vs OWmean_Total_ammonia



Histogram of Residuals of Mean_Growth



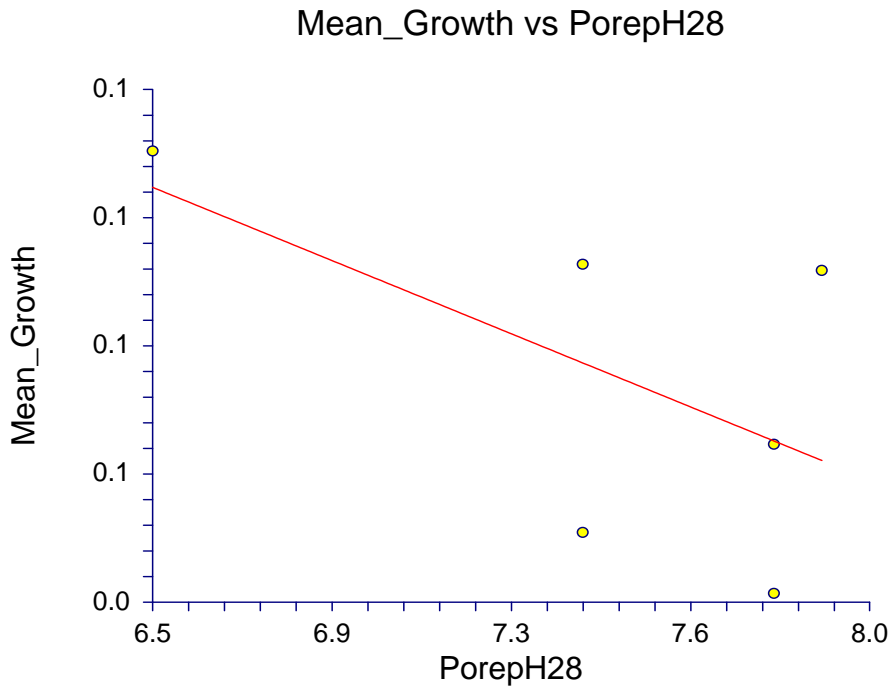
Normal Probability Plot of Residuals of Mean_Growth



Linear Regression Report

Page/Date/Time 1 8/17/2009 3:36:23 PM
Database
Y = Mean_Growth X = PorepH28

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	PorepH28	Rows Used in Estimation	6
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.3682	Rows Prediction Only	5
Slope	-0.0381	Sum of Frequencies	6
R-Squared	0.3419	Sum of Weights	6.0000
Correlation	-0.5847	Coefficient of Variation	0.3651
Mean Square Error	9.430429E-04	Square Root of MSE	0.030709

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:36:23 PM
Y = Mean_Growth X = PorepH28

Summary Statement

The equation of the straight line relating Mean_Growth and PorepH28 is estimated as:
 $\text{Mean_Growth} = (0.3682) + (-0.0381) \text{ PorepH28}$ using the 6 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when PorepH28 is zero, is 0.3682 with a standard error of 0.1975. The slope, the estimated change in Mean_Growth per unit change in PorepH28, is -0.0381 with a standard error of 0.0264. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in PorepH28, is 0.3419. The correlation between Mean_Growth and PorepH28 is -0.5847.

A significance test that the slope is zero resulted in a t-value of -1.4415. The significance level of this t-test is 0.2229. Since $0.2229 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0381. The lower limit of the 95% confidence interval for the slope is -0.1113 and the upper limit is 0.0352. The estimated intercept is 0.3682. The lower limit of the 95% confidence interval for the intercept is -0.1801 and the upper limit is 0.9166.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	PorepH28
Count	6	6
Mean	0.0841	7.4667
Standard Deviation	0.0339	0.5203
Minimum	0.0417	6.5000
Maximum	0.1280	7.9000

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:36:23 PM

Database

Y = Mean_Growth X = PorepH28

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.3682	-0.0381
Lower 95% Confidence Limit	-0.1801	-0.1113
Upper 95% Confidence Limit	0.9166	0.0352
Standard Error	0.1975	0.0264
Standardized Coefficient	0.0000	-0.5847
T Value	1.8645	-1.4415
Prob Level (T Test)	0.1357	0.2229
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.3002	0.2009
Regression of Y on X	0.3682	-0.0381
Inverse Regression from X on Y	0.9152	-0.1113
Orthogonal Regression of Y and X	0.3690	-0.0382

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.368236206896533) + (-3.80517241379291E-02) * (PorepH28)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	4.245368E-02	4.245368E-02			
Slope	1	1.959537E-03	1.959537E-03	2.0779	0.2229	0.2009
Error	4	3.772171E-03	9.430429E-04			
Lack of Fit	2	1.981121E-03	9.905607E-04	1.1061	0.4748	
Pure Error	2	1.79105E-03	8.95525E-04			
Adj. Total	5	5.731708E-03	1.146342E-03			
Total	6	4.818539E-02				

s = Square Root(9.430429E-04) = 0.030709

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:36:23 PM

Database

Y = Mean_Growth X = PorepH28

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9392	0.652463	Yes
Anderson Darling	0.2483	0.750354	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			
Constant Residual Variance?			
Modified Levene Test	0.0861	0.783777	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(2, 2) Test	1.1061	0.474806	Yes

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

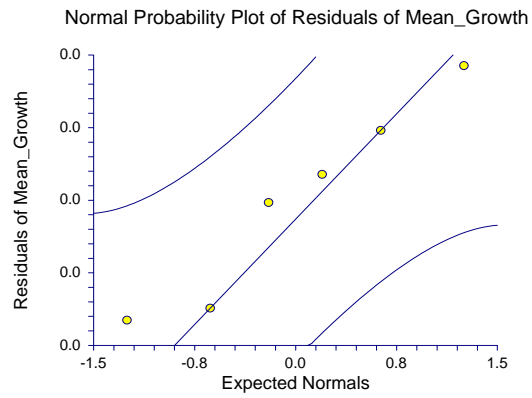
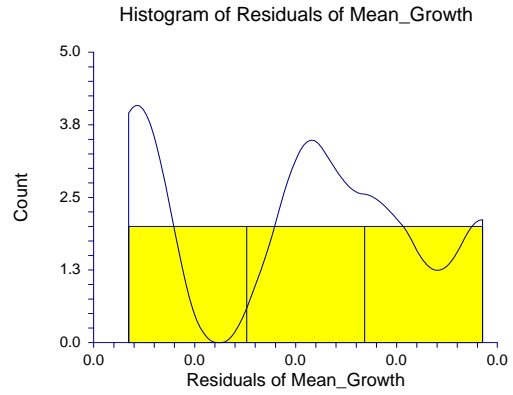
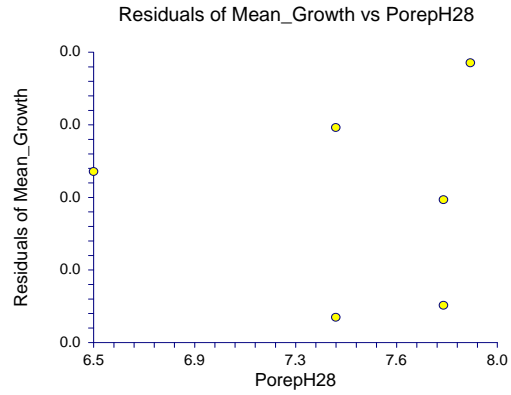
Linear Regression Report

Page/Date/Time 5 8/17/2009 3:36:23 PM

Database

Y = Mean_Growth X = PorepH28

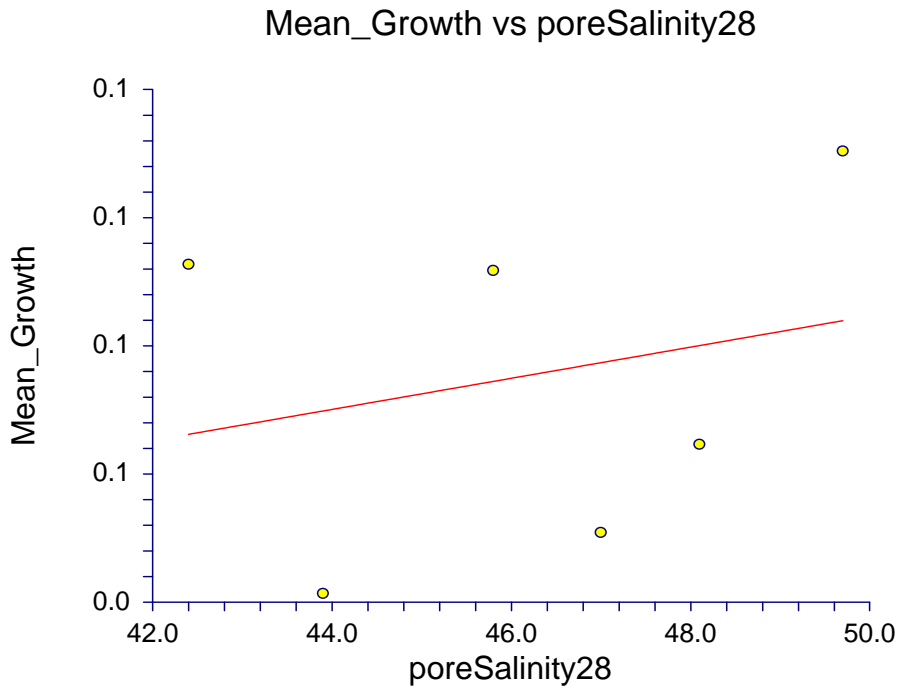
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/18/2009 7:55:55 AM
Database
Y = Mean_Growth X = poreSalinity28

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	poreSalinity28	Rows Used in Estimation	6
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	-0.0560	Rows Prediction Only	5
Slope	0.0030	Sum of Frequencies	6
R-Squared	0.0585	Sum of Weights	6.0000
Correlation	0.2418	Coefficient of Variation	0.4367
Mean Square Error	1.349122E-03	Square Root of MSE	3.673039E-02

Linear Regression Report

Page/Date/Time 2 8/18/2009 7:55:55 AM
Y = Mean_Growth X = poreSalinity28

Summary Statement

The equation of the straight line relating Mean_Growth and poreSalinity28 is estimated as:
 $\text{Mean_Growth} = (-0.0560) + (0.0030) \text{poreSalinity28}$ using the 6 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when poreSalinity28 is zero, is -0.0560 with a standard error of 0.2815. The slope, the estimated change in Mean_Growth per unit change in poreSalinity28, is 0.0030 with a standard error of 0.0061. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in poreSalinity28, is 0.0585. The correlation between Mean_Growth and poreSalinity28 is 0.2418.

A significance test that the slope is zero resulted in a t-value of 0.4985. The significance level of this t-test is 0.6443. Since $0.6443 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0030. The lower limit of the 95% confidence interval for the slope is -0.0139 and the upper limit is 0.0199. The estimated intercept is -0.0560. The lower limit of the 95% confidence interval for the intercept is -0.8374 and the upper limit is 0.7255.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	poreSalinity28
Count	6	6
Mean	0.0841	46.1500
Standard Deviation	0.0339	2.6972
Minimum	0.0417	42.4000
Maximum	0.1280	49.7000

Linear Regression Report

Page/Date/Time 3 8/18/2009 7:55:55 AM

Database

Y = Mean_Growth X = poreSalinity28

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-0.0560	0.0030
Lower 95% Confidence Limit	-0.8374	-0.0139
Upper 95% Confidence Limit	0.7255	0.0199
Standard Error	0.2815	0.0061
Standardized Coefficient	0.0000	0.2418
T Value	-0.1989	0.4985
Prob Level (T Test)	0.8520	0.6443
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.0528	0.0677
Regression of Y on X	-0.0560	0.0030
Inverse Regression from X on Y	-2.3113	0.0519
Orthogonal Regression of Y and X	-0.0560	0.0030

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(-5.59826804123722E-02) + (3.03573883161506E-03) * (\text{poreSalinity28})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	4.245368E-02	4.245368E-02			
Slope	1	3.352215E-04	3.352215E-04	0.2485	0.6443	0.0677
Error	4	5.396487E-03	1.349122E-03			
Adj. Total	5	5.731708E-03	1.146342E-03			
Total	6	4.818539E-02				

$s = \text{Square Root}(1.349122E-03) = 3.673039E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 7:55:55 AM

Database

Y = Mean_Growth X = poreSalinity28

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8170	0.083072	No
Anderson Darling	0.5487	0.157928	No
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			
Constant Residual Variance?			
Modified Levene Test	0.0013	0.972838	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

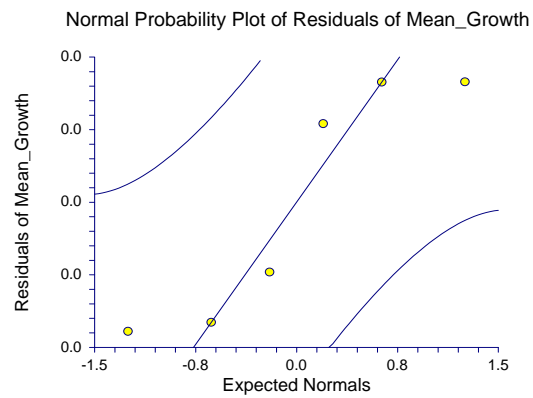
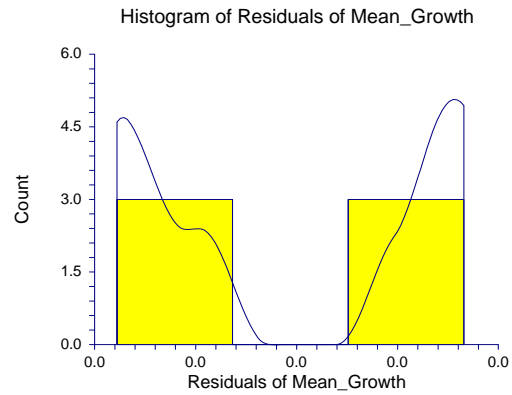
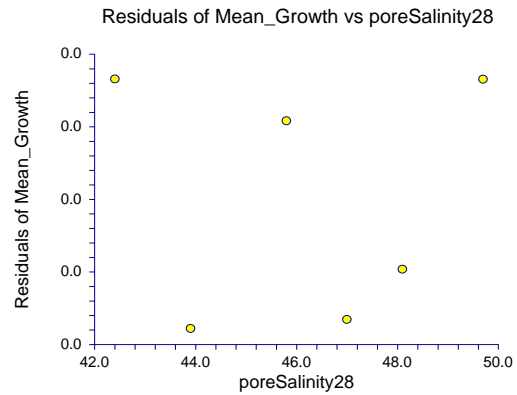
Linear Regression Report

Page/Date/Time 5 8/18/2009 7:55:55 AM

Database

Y = Mean_Growth X = poreSalinity28

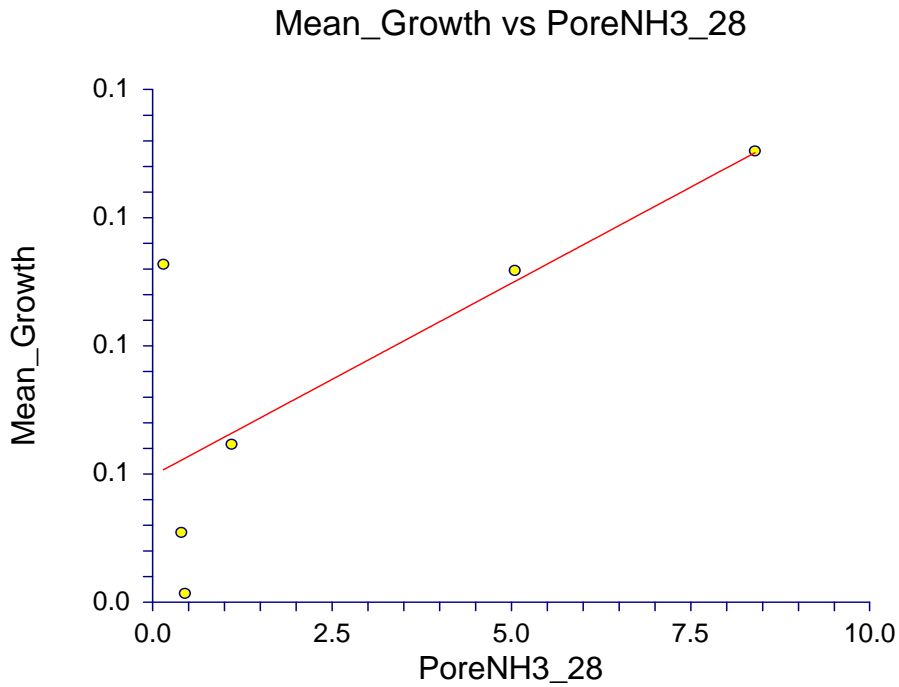
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 3:36:39 PM
Database
Y = Mean_Growth X = PoreNH3_28

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mean_Growth	Rows Processed	11
Independent Variable	PoreNH3_28	Rows Used in Estimation	6
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0647	Rows Prediction Only	5
Slope	0.0075	Sum of Frequencies	6
R-Squared	0.5621	Sum of Weights	6.0000
Correlation	0.7498	Coefficient of Variation	0.2978
Mean Square Error	6.274201E-04	Square Root of MSE	2.504835E-02

Linear Regression Report

Page/Date/Time 2 8/17/2009 3:36:39 PM
Y = Mean_Growth X = PoreNH3_28

Summary Statement

The equation of the straight line relating Mean_Growth and PoreNH3_28 is estimated as:
 $\text{Mean_Growth} = (0.0647) + (0.0075) \text{PoreNH3_28}$ using the 6 observations in this dataset. The y-intercept, the estimated value of Mean_Growth when PoreNH3_28 is zero, is 0.0647 with a standard error of 0.0133. The slope, the estimated change in Mean_Growth per unit change in PoreNH3_28, is 0.0075 with a standard error of 0.0033. The value of R-Squared, the proportion of the variation in Mean_Growth that can be accounted for by variation in PoreNH3_28, is 0.5621. The correlation between Mean_Growth and PoreNH3_28 is 0.7498.

A significance test that the slope is zero resulted in a t-value of 2.2661. The significance level of this t-test is 0.0861. Since $0.0861 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0075. The lower limit of the 95% confidence interval for the slope is -0.0017 and the upper limit is 0.0167. The estimated intercept is 0.0647. The lower limit of the 95% confidence interval for the intercept is 0.0276 and the upper limit is 0.1017.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Mean_Growth	PoreNH3_28
Count	6	6
Mean	0.0841	2.5917
Standard Deviation	0.0339	3.3869
Minimum	0.0417	0.1500
Maximum	0.1280	8.4000

Linear Regression Report

Page/Date/Time 3 8/17/2009 3:36:39 PM

Database

Y = Mean_Growth X = PoreNH3_28

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0647	0.0075
Lower 95% Confidence Limit	0.0276	-0.0017
Upper 95% Confidence Limit	0.1017	0.0167
Standard Error	0.0133	0.0033
Standardized Coefficient	0.0000	0.7498
T Value	4.8483	2.2661
Prob Level (T Test)	0.0083	0.0861
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9442	0.4099
Regression of Y on X	0.0647	0.0075
Inverse Regression from X on Y	0.0496	0.0133
Orthogonal Regression of Y and X	0.0647	0.0075

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(6.46921478747902E-02) + (7.49499117371437E-03) * (\text{PoreNH3_28})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	4.245368E-02	4.245368E-02			
Slope	1	3.222028E-03	3.222028E-03	5.1354	0.0861	0.4099
Error	4	2.50968E-03	6.274201E-04			
Adj. Total	5	5.731708E-03	1.146342E-03			
Total	6	4.818539E-02				

$s = \text{Square Root}(6.274201E-04) = 2.504835E-02$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 3:36:39 PM

Database

Y = Mean_Growth X = PoreNH3_28

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8992	0.369274	Yes
Anderson Darling	0.4215	0.322660	Yes
D'Agostino Skewness	0.0000		
D'Agostino Kurtosis		1.000000	Yes
D'Agostino Omnibus			
Constant Residual Variance?			
Modified Levene Test	1.5927	0.275509	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

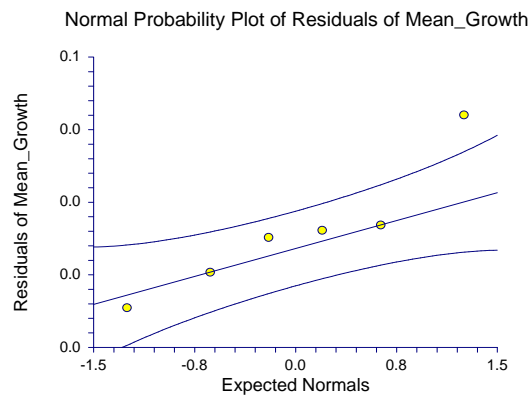
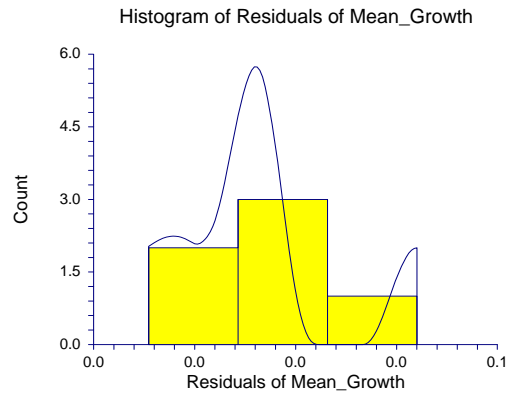
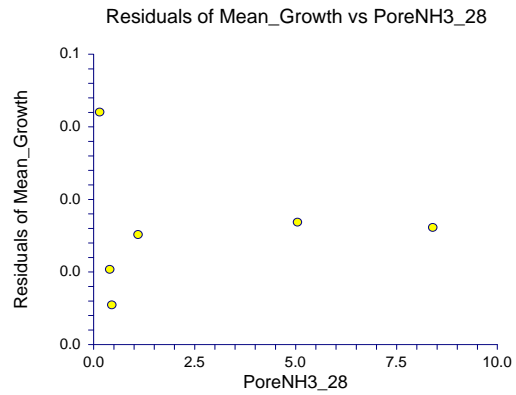
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 3:36:39 PM
Database
Y = Mean_Growth X = PoreNH3_28

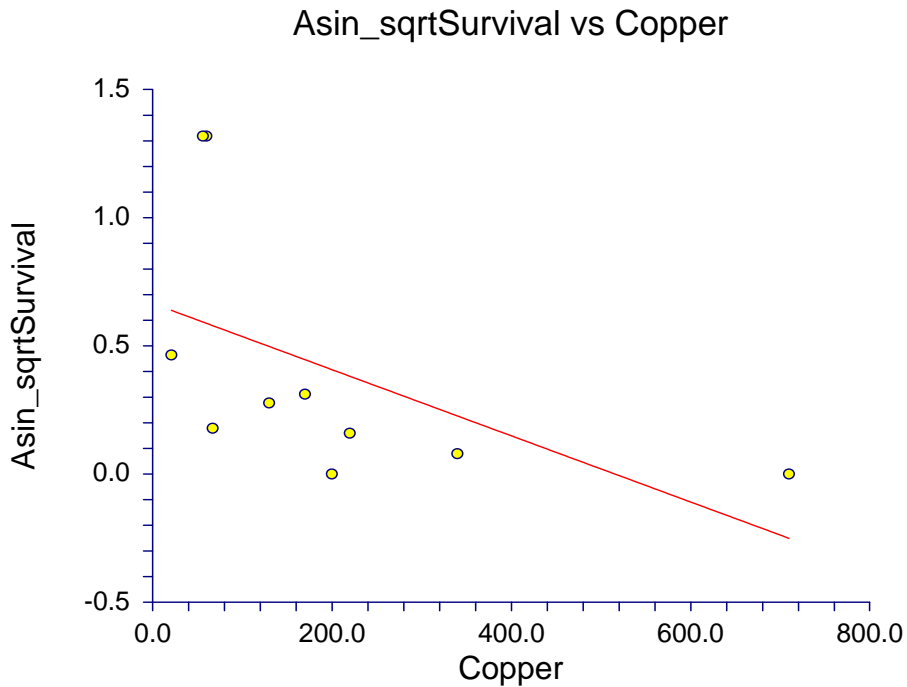
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 2:49:44 PM
Database
Y = Asin_sqrtSurvival X = Copper

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Copper	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.6650	Rows Prediction Only	0
Slope	-0.0013	Sum of Frequencies	10
R-Squared	0.2790	Sum of Weights	10.0000
Correlation	-0.5282	Coefficient of Variation	1.0953
Mean Square Error	0.2020667	Square Root of MSE	0.4495183

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:49:44 PM
Y = Asin_sqrtSurvival X = Copper

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Copper is estimated as:
 $\text{Asin_sqrtSurvival} = (0.6650) + (-0.0013) \text{Copper}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Copper is zero, is 0.6650 with a standard error of 0.2029. The slope, the estimated change in Asin_sqrtSurvival per unit change in Copper, is -0.0013 with a standard error of 0.0007. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Copper, is 0.2790. The correlation between Asin_sqrtSurvival and Copper is -0.5282.

A significance test that the slope is zero resulted in a t-value of -1.7592. The significance level of this t-test is 0.1166. Since $0.1166 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0013. The lower limit of the 95% confidence interval for the slope is -0.0030 and the upper limit is 0.0004. The estimated intercept is 0.6650. The lower limit of the 95% confidence interval for the intercept is 0.1972 and the upper limit is 1.1328.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Copper
Count	10	10
Mean	0.4104	197.4000
Standard Deviation	0.4991	204.3685
Minimum	0.0000	21.0000
Maximum	1.3180	710.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:49:44 PM

Database

Y = Asin_sqrtSurvival X = Copper

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.6650	-0.0013
Lower 95% Confidence Limit	0.1972	-0.0030
Upper 95% Confidence Limit	1.1328	0.0004
Standard Error	0.2029	0.0007
Standardized Coefficient	0.0000	-0.5282
T Value	3.2781	-1.7592
Prob Level (T Test)	0.0112	0.1166
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.8181	0.3413
Regression of Y on X	0.6650	-0.0013
Inverse Regression from X on Y	1.3232	-0.0046
Orthogonal Regression of Y and X	0.6650	-0.0013

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.665015890464019) + (-1.28984746942259E-03) * (Copper)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.6253846	0.6253846	3.0949	0.1166	0.3413
Error	8	1.616534	0.2020667			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

s = Square Root(0.2020667) = 0.4495183

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:49:44 PM

Database

Y = Asin_sqrtSurvival X = Copper

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7981	0.013762	No
Anderson Darling	0.9333	0.017979	No
D'Agostino Skewness	1.6591	0.097102	No
D'Agostino Kurtosis	0.1089	0.913246	Yes
D'Agostino Omnibus	2.7644	0.251028	Yes
Constant Residual Variance?			
Modified Levene Test	1.5114	0.253860	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

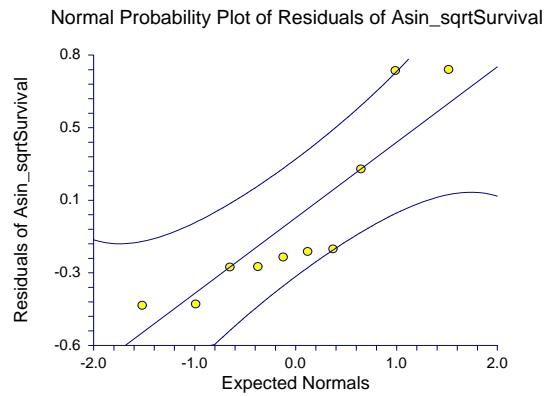
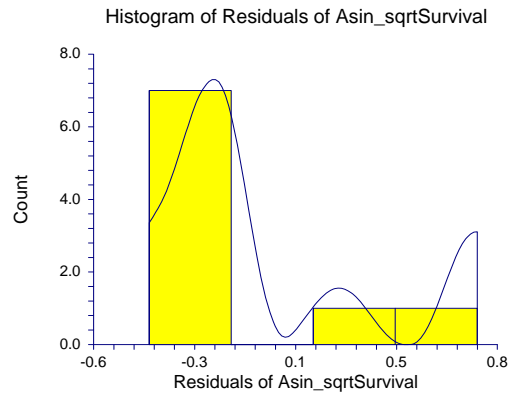
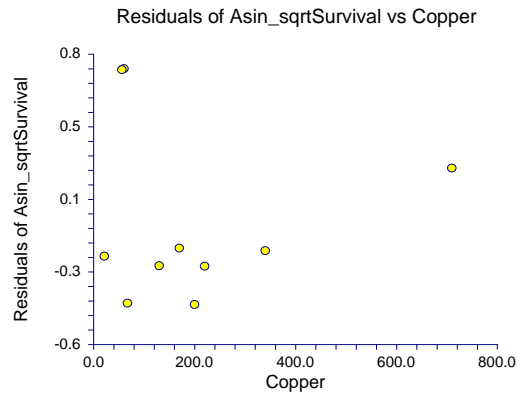
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 2:49:44 PM
Database
Y = Asin_sqrtSurvival X = Copper

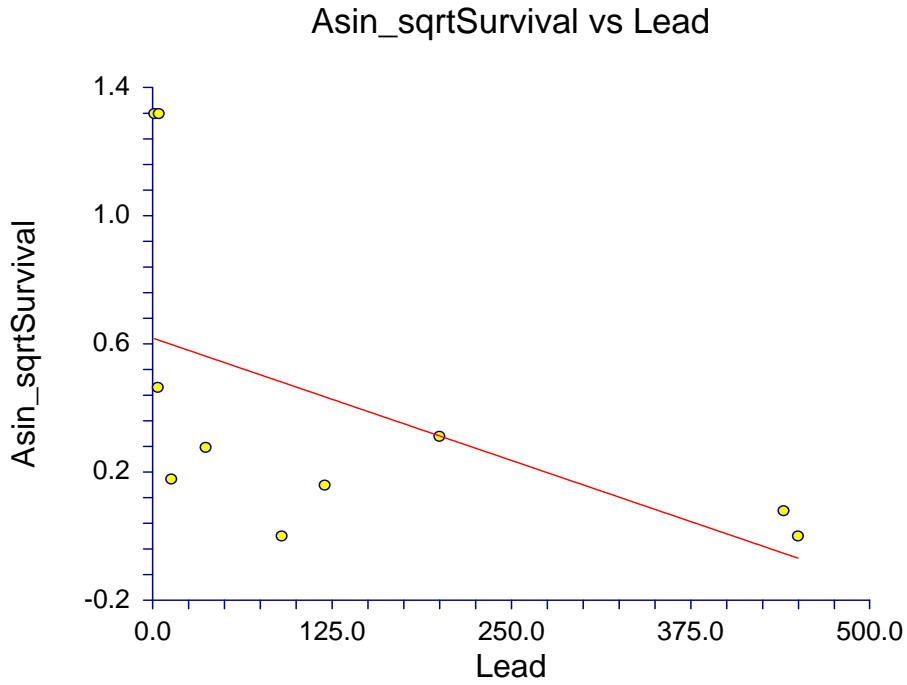
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 2:50:09 PM
Database
Y = Asin_sqrtSurvival X = Lead

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Lead	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.6178	Rows Prediction Only	0
Slope	-0.0015	Sum of Frequencies	10
R-Squared	0.2860	Sum of Weights	10.0000
Correlation	-0.5348	Coefficient of Variation	1.0900
Mean Square Error	0.2000944	Square Root of MSE	0.4473191

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:50:09 PM
Y = Asin_sqrtSurvival X = Lead

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Lead is estimated as:
 $\text{Asin_sqrtSurvival} = (0.6178) + (-0.0015) \text{Lead}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Lead is zero, is 0.6178 with a standard error of 0.1828. The slope, the estimated change in Asin_sqrtSurvival per unit change in Lead, is -0.0015 with a standard error of 0.0009. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Lead, is 0.2860. The correlation between Asin_sqrtSurvival and Lead is -0.5348.

A significance test that the slope is zero resulted in a t-value of -1.7901. The significance level of this t-test is 0.1112. Since $0.1112 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0015. The lower limit of the 95% confidence interval for the slope is -0.0035 and the upper limit is 0.0004. The estimated intercept is 0.6178. The lower limit of the 95% confidence interval for the intercept is 0.1961 and the upper limit is 1.0394.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Lead
Count	10	10
Mean	0.4104	135.9100
Standard Deviation	0.4991	174.9462
Minimum	0.0000	1.2000
Maximum	1.3180	450.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:50:09 PM

Database

Y = Asin_sqrtSurvival X = Lead

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.6178	-0.0015
Lower 95% Confidence Limit	0.1961	-0.0035
Upper 95% Confidence Limit	1.0394	0.0004
Standard Error	0.1828	0.0009
Standardized Coefficient	0.0000	-0.5348
T Value	3.3788	-1.7901
Prob Level (T Test)	0.0097	0.1112
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.8401	0.3512
Regression of Y on X	0.6178	-0.0015
Inverse Regression from X on Y	1.1354	-0.0053
Orthogonal Regression of Y and X	0.6178	-0.0015

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.617752764192215) + (-1.52566230735203E-03) * (Lead)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.641163	0.641163	3.2043	0.1112	0.3512
Error	8	1.600755	0.2000944			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

$s = \text{Square Root}(0.2000944) = 0.4473191$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:50:09 PM

Database

Y = Asin_sqrtSurvival X = Lead

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8813	0.135181	No
Anderson Darling	0.4936	0.216441	Yes
D'Agostino Skewness	1.2870	0.198105	No
D'Agostino Kurtosis	-0.0236	0.981138	Yes
D'Agostino Omnibus	1.6568	0.436737	Yes
Constant Residual Variance?			
Modified Levene Test	1.3398	0.280460	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

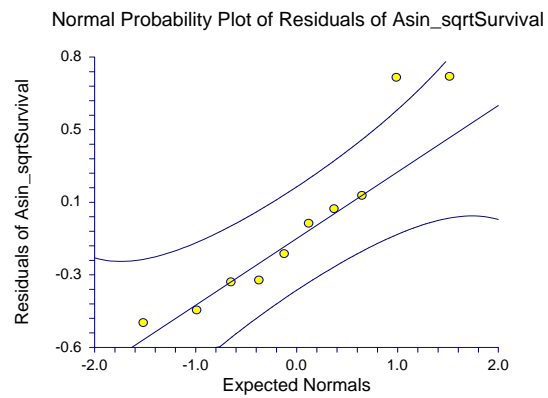
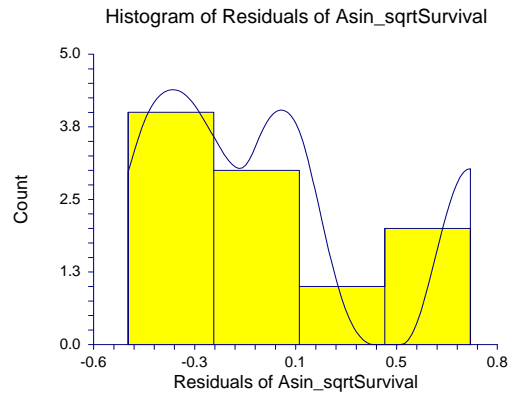
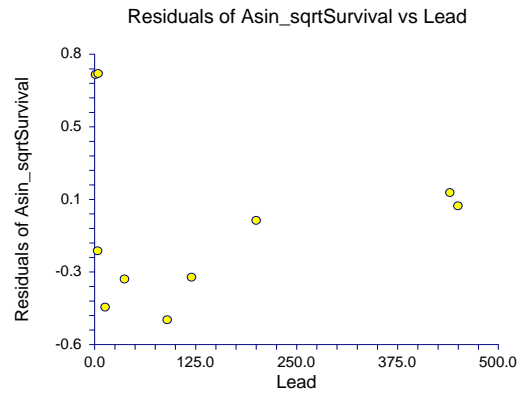
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 2:50:09 PM
Database
Y = Asin_sqrtSurvival X = Lead

Residual Plots Section



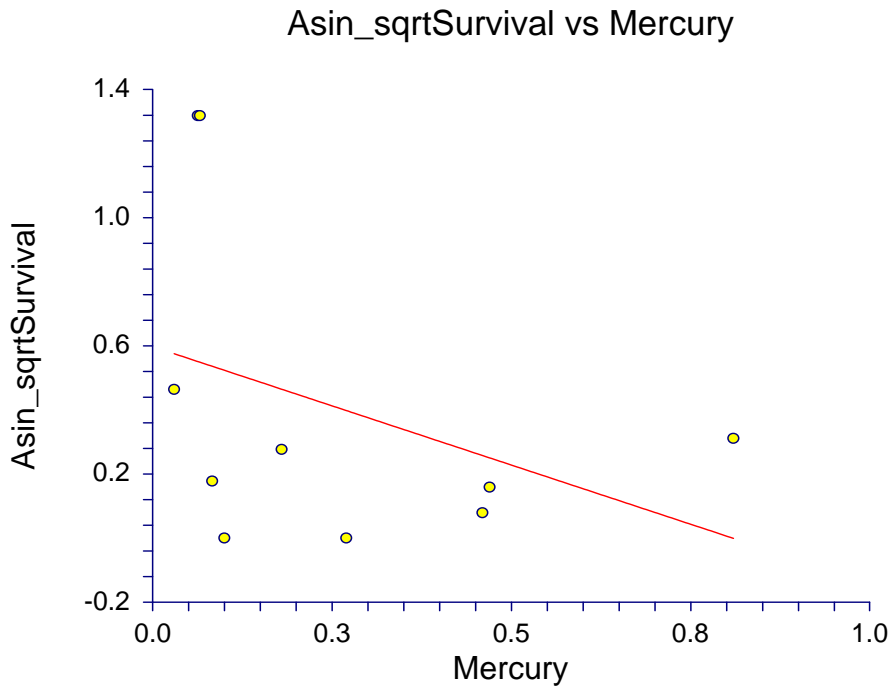
Linear Regression Report

Page/Date/Time 1 8/17/2009 2:51:01 PM

Database

Y = Asin_sqrtSurvival X = Mercury

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Mercury	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.5974	Rows Prediction Only	0
Slope	-0.7386	Sum of Frequencies	10
R-Squared	0.1409	Sum of Weights	10.0000
Correlation	-0.3753	Coefficient of Variation	1.1956
Mean Square Error	0.2407645	Square Root of MSE	0.4906775

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:51:01 PM
Y = Asin_sqrtSurvival X = Mercury

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Mercury is estimated as:
 $\text{Asin_sqrtSurvival} = (0.5974) + (-0.7386) \text{ Mercury}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Mercury is zero, is 0.5974 with a standard error of 0.2253. The slope, the estimated change in Asin_sqrtSurvival per unit change in Mercury, is -0.7386 with a standard error of 0.6449. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Mercury, is 0.1409. The correlation between Asin_sqrtSurvival and Mercury is -0.3753.

A significance test that the slope is zero resulted in a t-value of -1.1453. The significance level of this t-test is 0.2852. Since $0.2852 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.7386. The lower limit of the 95% confidence interval for the slope is -2.2257 and the upper limit is 0.7485. The estimated intercept is 0.5974. The lower limit of the 95% confidence interval for the intercept is 0.0780 and the upper limit is 1.1168.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Mercury
Count	10	10
Mean	0.4104	0.2532
Standard Deviation	0.4991	0.2536
Minimum	0.0000	0.0300
Maximum	1.3180	0.8100

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:51:01 PM

Database

Y = Asin_sqrtSurvival X = Mercury

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.5974	-0.7386
Lower 95% Confidence Limit	0.0780	-2.2257
Upper 95% Confidence Limit	1.1168	0.7485
Standard Error	0.2253	0.6449
Standardized Coefficient	0.0000	-0.3753
T Value	2.6522	-1.1453
Prob Level (T Test)	0.0292	0.2852
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.6433	0.1731
Regression of Y on X	0.5974	-0.7386
Inverse Regression from X on Y	1.7380	-5.2433
Orthogonal Regression of Y and X	1.4565	-4.1314

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.597410323786913) + (-.738587376725566) * (Mercury)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.3158028	0.3158028	1.3117	0.2852	0.1731
Error	8	1.926116	0.2407645			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

$s = \text{Square Root}(0.2407645) = 0.4906775$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:51:01 PM

Database

Y = Asin_sqrtSurvival X = Mercury

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8548	0.066273	No
Anderson Darling	0.6656	0.082244	No
D'Agostino Skewness	1.3869	0.165463	No
D'Agostino Kurtosis	-0.1469	0.883234	Yes
D'Agostino Omnibus	1.9451	0.378109	Yes

Constant Residual Variance?

Modified Levene Test	2.6829	0.140064	No
----------------------	--------	----------	----

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

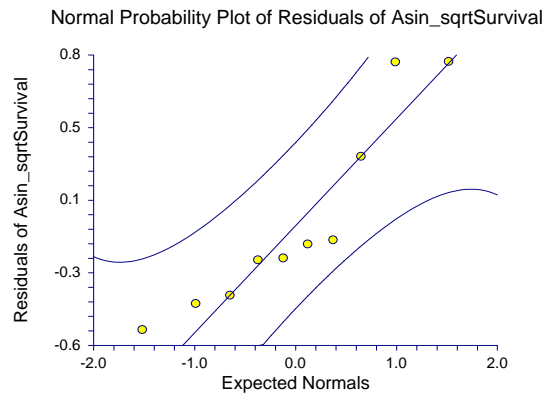
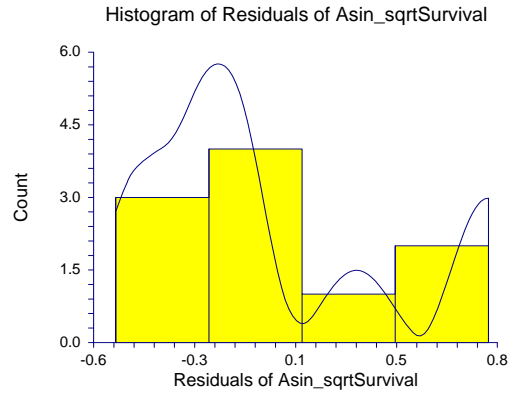
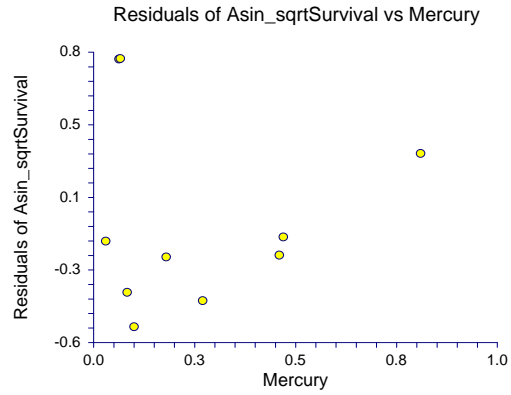
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:51:01 PM

Database

Y = Asin_sqrtSurvival X = Mercury

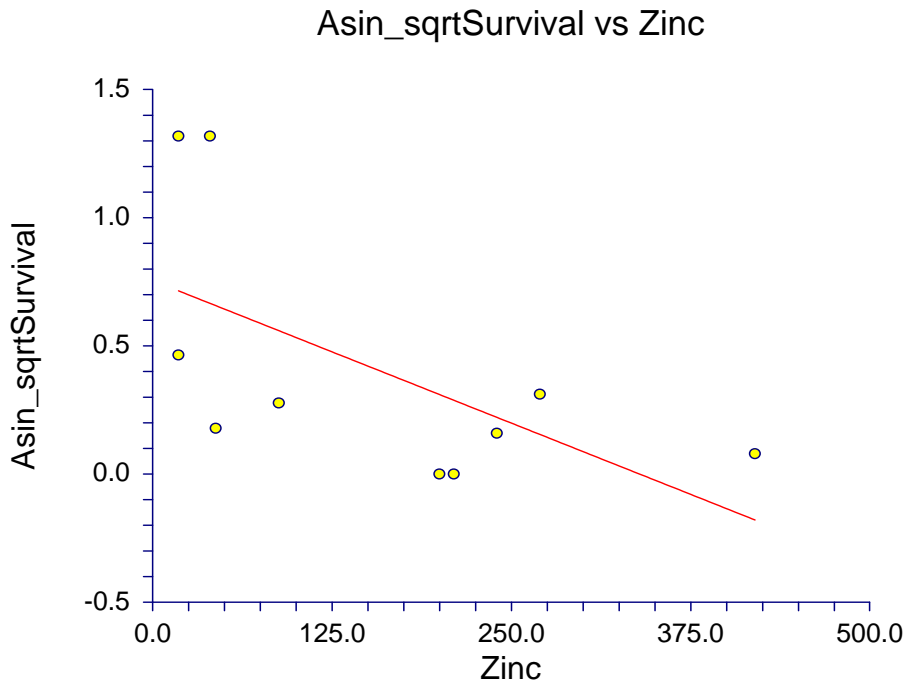
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 2:51:17 PM
Database
Y = Asin_sqrtSurvival X = Zinc

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Zinc	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.7545	Rows Prediction Only	0
Slope	-0.0022	Sum of Frequencies	10
R-Squared	0.3599	Sum of Weights	10.0000
Correlation	-0.5999	Coefficient of Variation	1.0320
Mean Square Error	0.1793823	Square Root of MSE	0.4235355

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:51:17 PM
Y = Asin_sqrtSurvival X = Zinc

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Zinc is estimated as:
 $\text{Asin_sqrtSurvival} = (0.7545) + (-0.0022) \text{Zinc}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Zinc is zero, is 0.7545 with a standard error of 0.2104. The slope, the estimated change in Asin_sqrtSurvival per unit change in Zinc, is -0.0022 with a standard error of 0.0010. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Zinc, is 0.3599. The correlation between Asin_sqrtSurvival and Zinc is -0.5999.

A significance test that the slope is zero resulted in a t-value of -2.1208. The significance level of this t-test is 0.0667. Since $0.0667 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0022. The lower limit of the 95% confidence interval for the slope is -0.0046 and the upper limit is 0.0002. The estimated intercept is 0.7545. The lower limit of the 95% confidence interval for the intercept is 0.2693 and the upper limit is 1.2396.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Zinc
Count	10	10
Mean	0.4104	154.8000
Standard Deviation	0.4991	134.7003
Minimum	0.0000	18.0000
Maximum	1.3180	420.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:51:17 PM

Database

Y = Asin_sqrtSurvival X = Zinc

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.7545	-0.0022
Lower 95% Confidence Limit	0.2693	-0.0046
Upper 95% Confidence Limit	1.2396	0.0002
Standard Error	0.2104	0.0010
Standardized Coefficient	0.0000	-0.5999
T Value	3.5863	-2.1208
Prob Level (T Test)	0.0071	0.0667
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.8796	0.4626
Regression of Y on X	0.7545	-0.0022
Inverse Regression from X on Y	1.3665	-0.0062
Orthogonal Regression of Y and X	0.7545	-0.0022

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.754496355120957) + (-2.22284467132401E-03) * (Zinc)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.8068597	0.8068597	4.4980	0.0667	0.4626
Error	8	1.435059	0.1793823			
Lack of Fit	7	1.070401	0.1529144	0.4193	0.8336	
Pure Error	1	0.364658	0.364658			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

s = Square Root(0.1793823) = 0.4235355

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:51:17 PM

Database

Y = Asin_sqrtSurvival X = Zinc

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8864	0.154282	No
Anderson Darling	0.5278	0.178163	No
D'Agostino Skewness	1.0303	0.302859	Yes
D'Agostino Kurtosis	-0.6668	0.504870	Yes
D'Agostino Omnibus	1.5062	0.470893	Yes

Constant Residual Variance?

Modified Levene Test	0.9579	0.356384	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(7, 1) Test	0.4193	0.833561	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

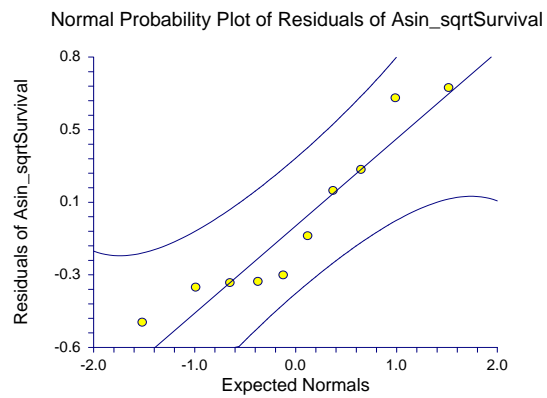
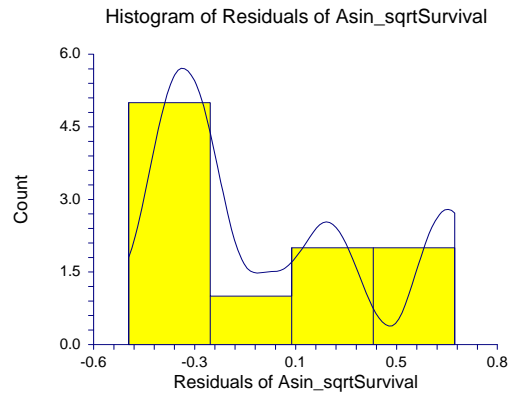
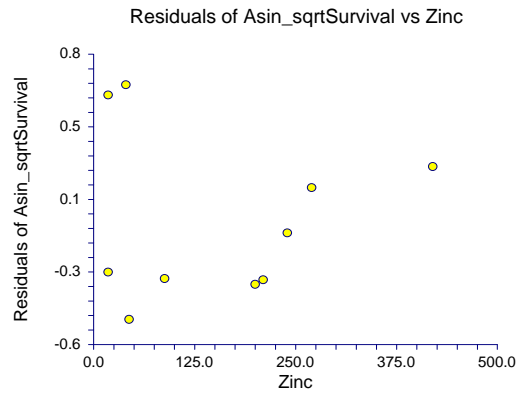
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:51:17 PM

Database

Y = Asin_sqrtSurvival X = Zinc

Residual Plots Section



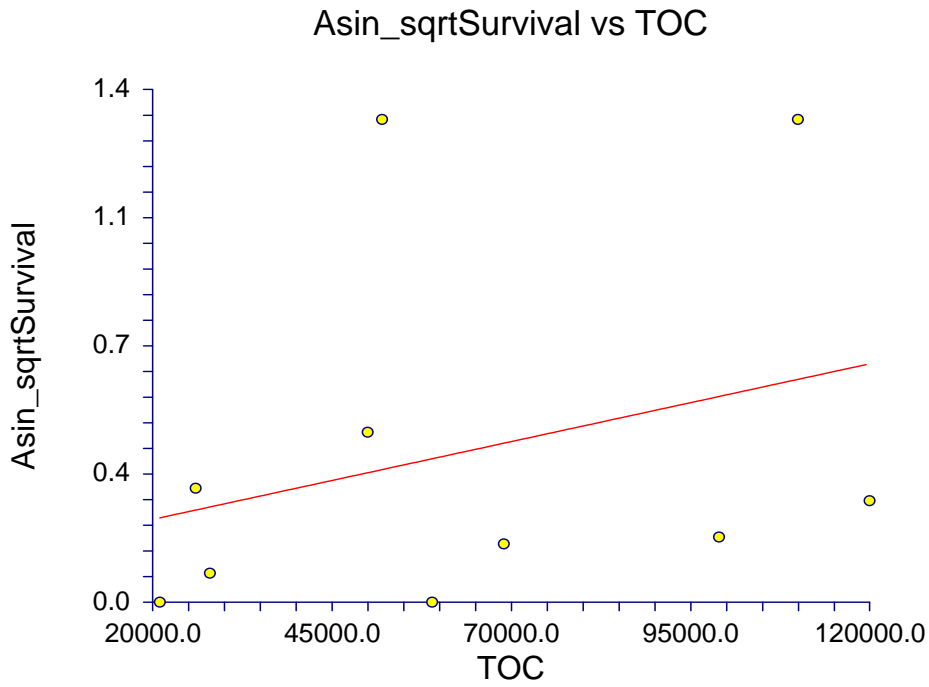
Linear Regression Report

Page/Date/Time 1 8/17/2009 2:52:41 PM

Database

Y = Asin_sqrtSurvival X = TOC

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	TOC	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.1411	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	10
R-Squared	0.0922	Sum of Weights	10.0000
Correlation	0.3036	Coefficient of Variation	1.2290
Mean Square Error	0.2544029	Square Root of MSE	0.5043837

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:52:41 PM
Y = Asin_sqrtSurvival X = TOC

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and TOC is estimated as:
 $\text{Asin_sqrtSurvival} = (0.1411) + (0.0000) \text{ TOC}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when TOC is zero, is 0.1411 with a standard error of 0.3387. The slope, the estimated change in Asin_sqrtSurvival per unit change in TOC, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in TOC, is 0.0922. The correlation between Asin_sqrtSurvival and TOC is 0.3036.

A significance test that the slope is zero resulted in a t-value of 0.9014. The significance level of this t-test is 0.3937. Since $0.3937 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.1411. The lower limit of the 95% confidence interval for the intercept is -0.6400 and the upper limit is 0.9221.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	TOC
Count	10	10
Mean	0.4104	63400.0000
Standard Deviation	0.4991	35671.9622
Minimum	0.0000	21000.0000
Maximum	1.3180	120000.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:52:41 PM

Database

Y = Asin_sqrtSurvival X = TOC

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.1411	0.0000
Lower 95% Confidence Limit	-0.6400	0.0000
Upper 95% Confidence Limit	0.9221	0.0000
Standard Error	0.3387	0.0000
Standardized Coefficient	0.0000	0.3036
T Value	0.4164	0.9014
Prob Level (T Test)	0.6880	0.3937
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.0657	0.1254
Regression of Y on X	0.1411	0.0000
Inverse Regression from X on Y	-2.5110	0.0000
Orthogonal Regression of Y and X	0.1411	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.141056843980301) + (4.24831476371765E-06) * (TOC)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.206695	0.206695	0.8125	0.3937	0.1254
Error	8	2.035223	0.2544029			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

$s = \text{Square Root}(0.2544029) = 0.5043837$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:52:41 PM

Database

Y = Asin_sqrtSurvival X = TOC

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8047	0.016549	No
Anderson Darling	0.8481	0.029172	No
D'Agostino Skewness	1.9131	0.055733	No
D'Agostino Kurtosis	0.6551	0.512411	Yes
D'Agostino Omnibus	4.0892	0.129435	No
Constant Residual Variance?			
Modified Levene Test	0.0410	0.844634	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

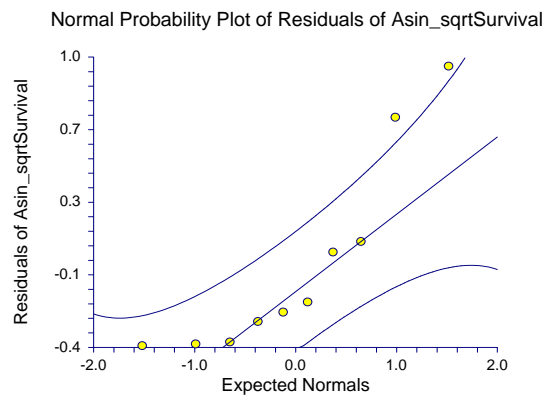
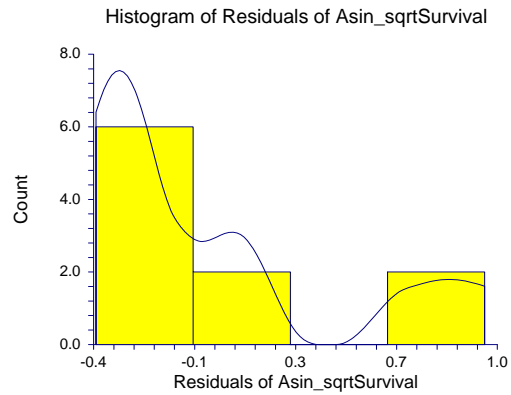
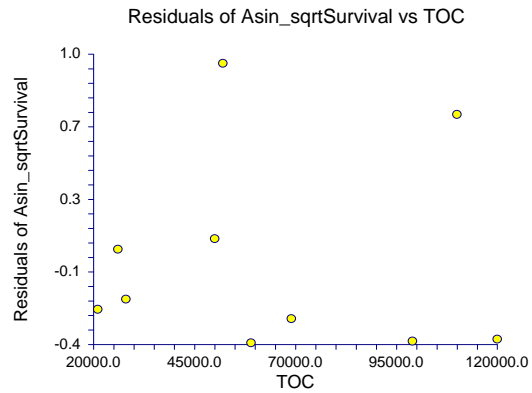
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:52:41 PM

Database

Y = Asin_sqrtSurvival X = TOC

Residual Plots Section



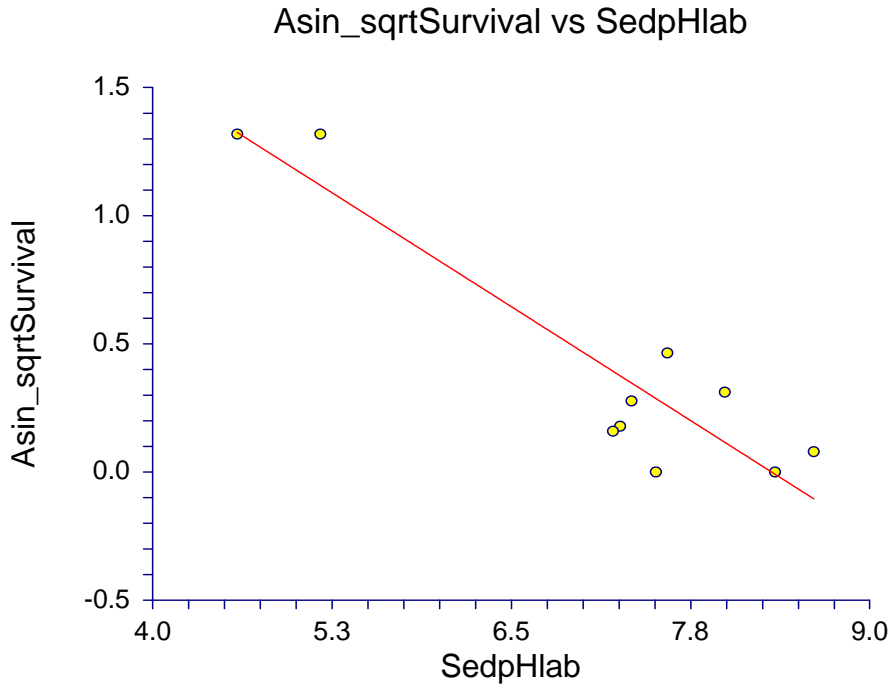
Linear Regression Report

Page/Date/Time 1 8/17/2009 2:52:19 PM

Database

Y = Asin_sqrtSurvival X = SedpHlab

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	SedpHlab	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	2.9552	Rows Prediction Only	0
Slope	-0.3554	Sum of Frequencies	10
R-Squared	0.8506	Sum of Weights	10.0000
Correlation	-0.9223	Coefficient of Variation	0.4986
Mean Square Error	4.186322E-02	Square Root of MSE	0.204605

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:52:19 PM

Y = Asin_sqrtSurvival X = SedpHlab

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and SedpHlab is estimated as:
 $\text{Asin_sqrtSurvival} = (2.9552) + (-0.3554) \text{ SedpHlab}$ using the 10 observations in this dataset.
The y-intercept, the estimated value of Asin_sqrtSurvival when SedpHlab is zero, is 2.9552 with a standard error of 0.3825. The slope, the estimated change in Asin_sqrtSurvival per unit change in SedpHlab, is -0.3554 with a standard error of 0.0527. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in SedpHlab, is 0.8506. The correlation between Asin_sqrtSurvival and SedpHlab is -0.9223.

A significance test that the slope is zero resulted in a t-value of -6.7493. The significance level of this t-test is 0.0001. Since $0.0001 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is -0.3554. The lower limit of the 95% confidence interval for the slope is -0.4768 and the upper limit is -0.2339. The estimated intercept is 2.9552. The lower limit of the 95% confidence interval for the intercept is 2.0730 and the upper limit is 3.8373.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	SedpHlab
Count	10	10
Mean	0.4104	7.1610
Standard Deviation	0.4991	1.2953
Minimum	0.0000	4.5900
Maximum	1.3180	8.6100

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:52:19 PM

Database

Y = Asin_sqrtSurvival X = SedpHlab

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	2.9552	-0.3554
Lower 95% Confidence Limit	2.0730	-0.4768
Upper 95% Confidence Limit	3.8373	-0.2339
Standard Error	0.3825	0.0527
Standardized Coefficient	0.0000	-0.9223
T Value	7.7249	-6.7493
Prob Level (T Test)	0.0001	0.0001
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	1.0000	0.9999
Regression of Y on X	2.9552	-0.3554
Inverse Regression from X on Y	3.4021	-0.4178
Orthogonal Regression of Y and X	3.0062	-0.3625

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(2.95515698204566) + (-.355363354565795) * (\text{SedpHlab})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	1.907013	1.907013	45.5534	0.0001	0.9999
Error	8	0.3349057	4.186322E-02			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

$s = \text{Square Root}(4.186322\text{E-}02) = 0.204605$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:52:19 PM

Database

Y = Asin_sqrtSurvival X = SedpHlab

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8743	0.112086	No
Anderson Darling	0.5147	0.191947	No
D'Agostino Skewness	-0.4061	0.684690	Yes
D'Agostino Kurtosis	-1.5648	0.117641	No
D'Agostino Omnibus	2.6133	0.270720	Yes
Constant Residual Variance?			
Modified Levene Test	0.0115	0.917299	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

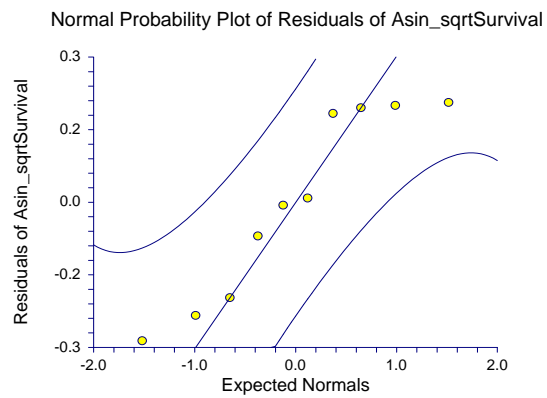
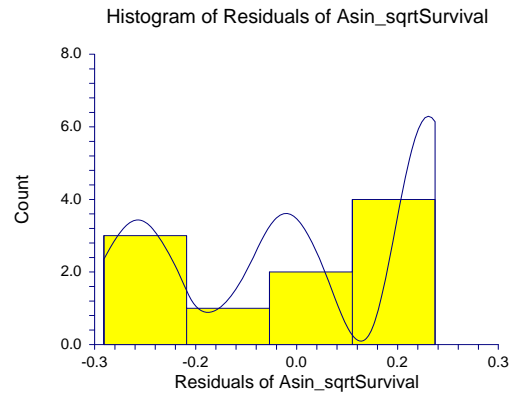
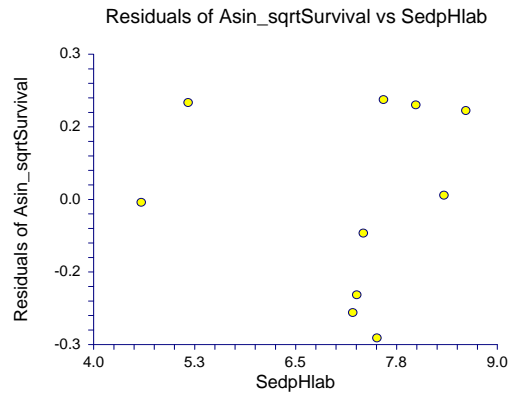
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:52:19 PM

Database

Y = Asin_sqrtSurvival X = SedpHlab

Residual Plots Section



Linear Regression Report

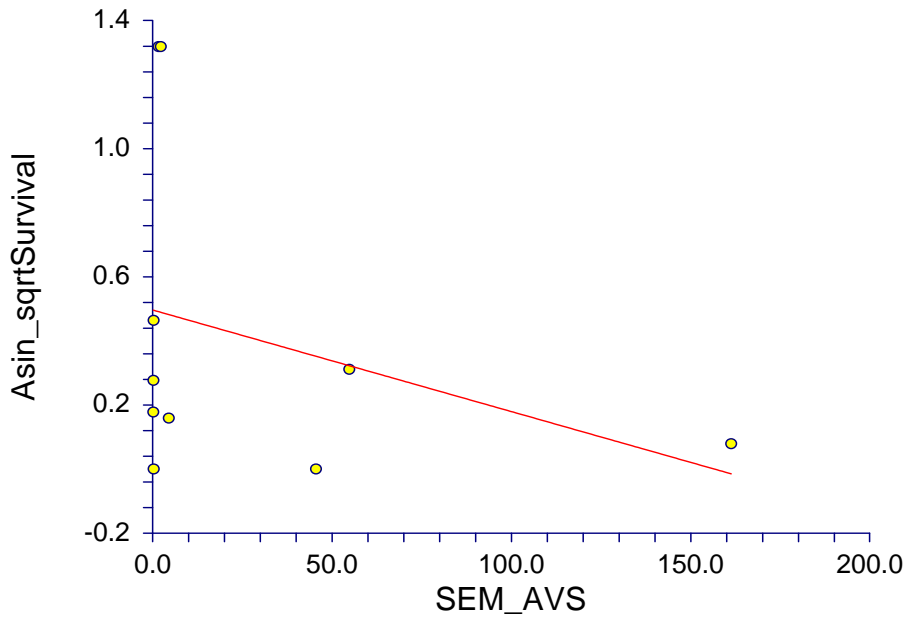
Page/Date/Time 1 9/18/2009 10:04:40 AM

Database

Y = Asin_sqrtSurvival X = SEM_AVS

Linear Regression Plot Section

Asin_sqrtSurvival vs SEM_AVS



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	SEM_AVS	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.4963	Rows Prediction Only	0
Slope	-0.0032	Sum of Frequencies	10
R-Squared	0.1065	Sum of Weights	10.0000
Correlation	-0.3264	Coefficient of Variation	1.2193
Mean Square Error	0.2503909	Square Root of MSE	0.5003907

Linear Regression Report

Page/Date/Time 2 9/18/2009 10:04:40 AM
Y = Asin_sqrtSurvival X = SEM_AVS

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and SEM_AVS is estimated as:
 $\text{Asin_sqrtSurvival} = (0.4963) + (-0.0032) \text{ SEM_AVS}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when SEM_AVS is zero, is 0.4963 with a standard error of 0.1811. The slope, the estimated change in Asin_sqrtSurvival per unit change in SEM_AVS, is -0.0032 with a standard error of 0.0032. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in SEM_AVS, is 0.1065. The correlation between Asin_sqrtSurvival and SEM_AVS is -0.3264.

A significance test that the slope is zero resulted in a t-value of -0.9766. The significance level of this t-test is 0.3574. Since $0.3574 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0032. The lower limit of the 95% confidence interval for the slope is -0.0106 and the upper limit is 0.0043. The estimated intercept is 0.4963. The lower limit of the 95% confidence interval for the intercept is 0.0788 and the upper limit is 0.9138.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	SEM_AVS
Count	10	10
Mean	0.4104	27.1279
Standard Deviation	0.4991	51.4284
Minimum	0.0000	0.1901
Maximum	1.3180	161.3828

Linear Regression Report

Page/Date/Time 3 9/18/2009 10:04:40 AM

Database

Y = Asin_sqrtSurvival X = SEM_AVS

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.4963	-0.0032
Lower 95% Confidence Limit	0.0788	-0.0106
Upper 95% Confidence Limit	0.9138	0.0043
Standard Error	0.1811	0.0032
Standardized Coefficient	0.0000	-0.3264
T Value	2.7413	-0.9766
Prob Level (T Test)	0.0254	0.3574
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.6717	0.1388
Regression of Y on X	0.4963	-0.0032
Inverse Regression from X on Y	1.2171	-0.0297
Orthogonal Regression of Y and X	0.4963	-0.0032

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.496321219199477) + (-3.1672674338043E-03) * (SEM_AVS)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.2387913	0.2387913	0.9537	0.3574	0.1388
Error	8	2.003127	0.2503909			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

$s = \text{Square Root}(0.2503909) = 0.5003907$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/18/2009 10:04:40 AM

Database

Y = Asin_sqrtSurvival X = SEM_AVS

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8205	0.025709	No
Anderson Darling	0.7975	0.038880	No
D'Agostino Skewness	1.7235	0.084792	No
D'Agostino Kurtosis	0.3818	0.702593	Yes
D'Agostino Omnibus	3.1164	0.210519	Yes
Constant Residual Variance?			
Modified Levene Test	0.0001	0.992861	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

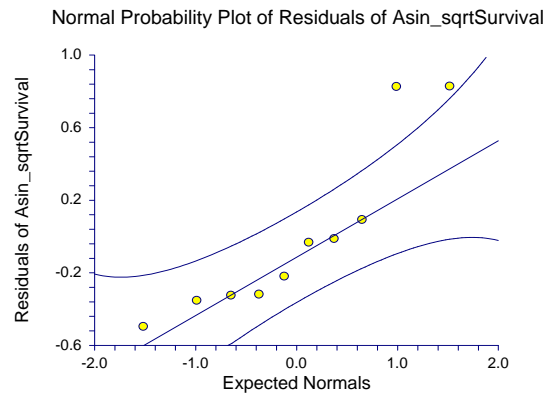
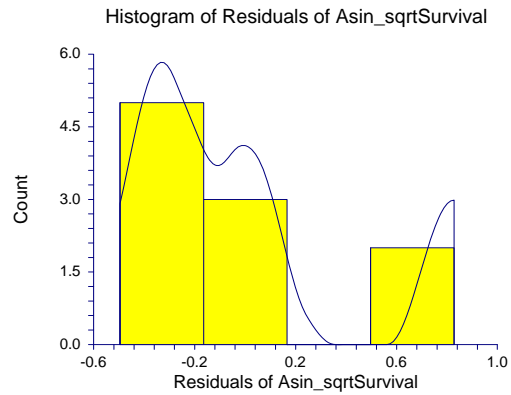
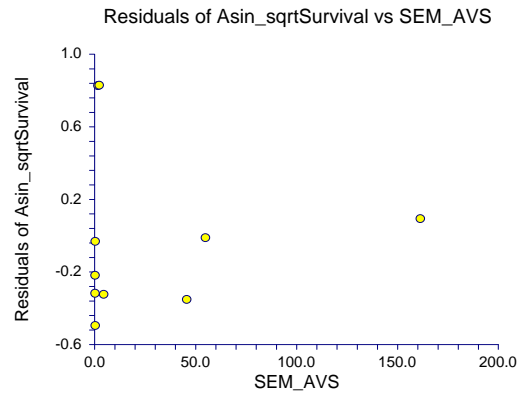
Linear Regression Report

Page/Date/Time 5 9/18/2009 10:04:40 AM

Database

Y = Asin_sqrtSurvival X = SEM_AVS

Residual Plots Section



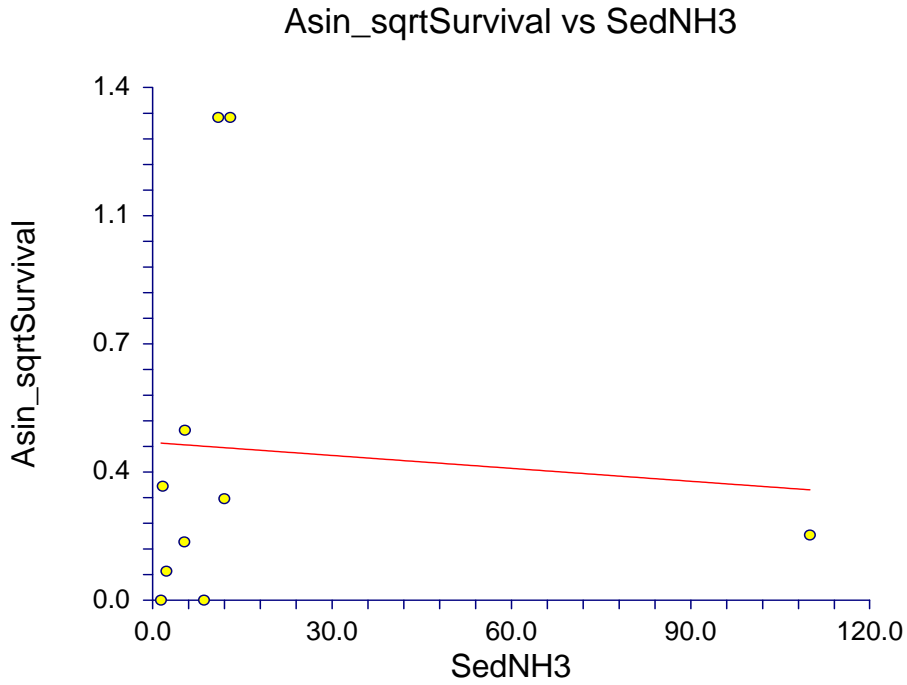
Linear Regression Report

Page/Date/Time 1 8/17/2009 2:51:48 PM

Database

Y = Asin_sqrtSurvival X = SedNH3

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	SedNH3	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.4304	Rows Prediction Only	0
Slope	-0.0012	Sum of Frequencies	10
R-Squared	0.0060	Sum of Weights	10.0000
Correlation	-0.0775	Coefficient of Variation	1.2860
Mean Square Error	0.2785579	Square Root of MSE	0.5277858

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:51:48 PM
Y = Asin_sqrtSurvival X = SedNH3

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and SedNH3 is estimated as:
 $\text{Asin_sqrtSurvival} = (0.4304) + (-0.0012) \text{ SedNH3}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when SedNH3 is zero, is 0.4304 with a standard error of 0.1902. The slope, the estimated change in Asin_sqrtSurvival per unit change in SedNH3, is -0.0012 with a standard error of 0.0053. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in SedNH3, is 0.0060. The correlation between Asin_sqrtSurvival and SedNH3 is -0.0775.

A significance test that the slope is zero resulted in a t-value of -0.2198. The significance level of this t-test is 0.8315. Since $0.8315 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0012. The lower limit of the 95% confidence interval for the slope is -0.0135 and the upper limit is 0.0111. The estimated intercept is 0.4304. The lower limit of the 95% confidence interval for the intercept is -0.0081 and the upper limit is 0.8690.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	SedNH3
Count	10	10
Mean	0.4104	17.0700
Standard Deviation	0.4991	32.9334
Minimum	0.0000	1.4000
Maximum	1.3180	110.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:51:48 PM

Database

Y = Asin_sqrtSurvival X = SedNH3

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.4304	-0.0012
Lower 95% Confidence Limit	-0.0081	-0.0135
Upper 95% Confidence Limit	0.8690	0.0111
Standard Error	0.1902	0.0053
Standardized Coefficient	0.0000	-0.0775
T Value	2.2633	-0.2198
Prob Level (T Test)	0.0534	0.8315
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.5119	0.0544
Regression of Y on X	0.4304	-0.0012
Inverse Regression from X on Y	3.7496	-0.1956
Orthogonal Regression of Y and X	0.4304	-0.0012

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.430441190448067) + (-1.17405919438005E-03) * (SedNH3)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.0134554	0.0134554	0.0483	0.8315	0.0544
Error	8	2.228463	0.2785579			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

$s = \text{Square Root}(0.2785579) = 0.5277858$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:51:48 PM

Database

Y = Asin_sqrtSurvival X = SedNH3

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7590	0.004598	No
Anderson Darling	1.0788	0.007880	No
D'Agostino Skewness	2.0195	0.043434	No
D'Agostino Kurtosis	0.6844	0.493718	Yes
D'Agostino Omnibus	4.5468	0.102960	No
Constant Residual Variance?			
Modified Levene Test	1.9694	0.198118	No
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

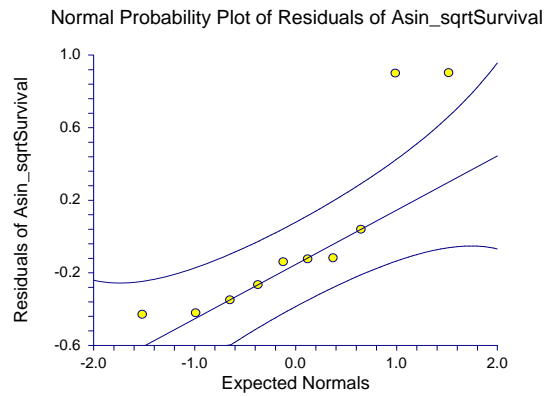
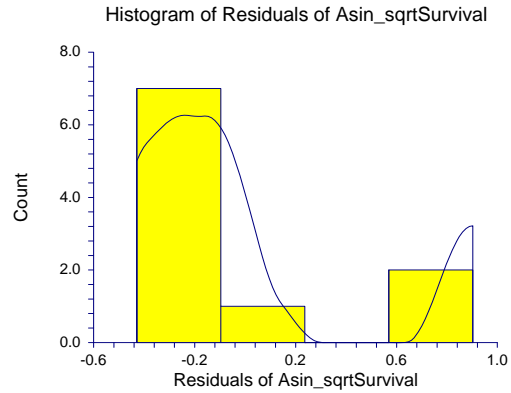
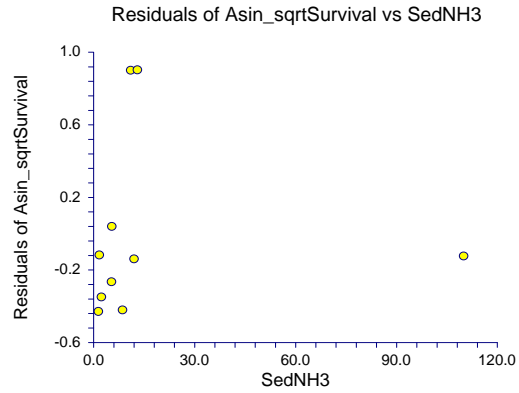
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:51:48 PM

Database

Y = Asin_sqrtSurvival X = SedNH3

Residual Plots Section



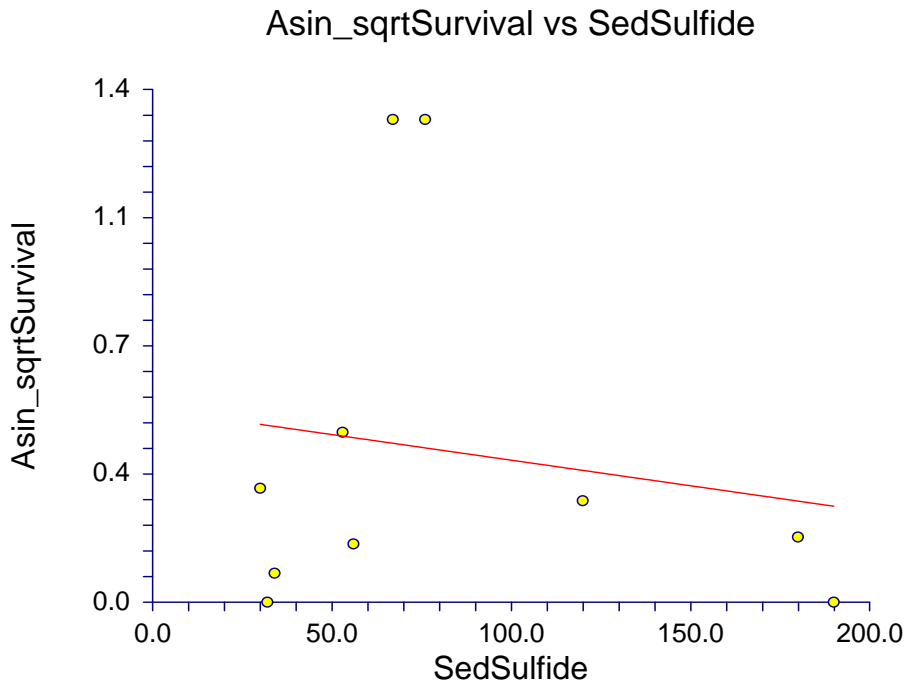
Linear Regression Report

Page/Date/Time 1 8/17/2009 2:52:03 PM

Database

Y = Asin_sqrtSurvival X = SedSulfide

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	SedSulfide	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.5275	Rows Prediction Only	0
Slope	-0.0014	Sum of Frequencies	10
R-Squared	0.0278	Sum of Weights	10.0000
Correlation	-0.1668	Coefficient of Variation	1.2718
Mean Square Error	0.2724441	Square Root of MSE	0.5219618

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:52:03 PM
Y = Asin_sqrtSurvival X = SedSulfide

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and SedSulfide is estimated as:
 $\text{Asin_sqrtSurvival} = (0.5275) + (-0.0014) \text{ SedSulfide}$ using the 10 observations in this dataset.
The y-intercept, the estimated value of Asin_sqrtSurvival when SedSulfide is zero, is 0.5275 with a standard error of 0.2951. The slope, the estimated change in Asin_sqrtSurvival per unit change in SedSulfide, is -0.0014 with a standard error of 0.0029. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in SedSulfide, is 0.0278. The correlation between Asin_sqrtSurvival and SedSulfide is -0.1668.

A significance test that the slope is zero resulted in a t-value of -0.4784. The significance level of this t-test is 0.6451. Since $0.6451 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0014. The lower limit of the 95% confidence interval for the slope is -0.0081 and the upper limit is 0.0053. The estimated intercept is 0.5275. The lower limit of the 95% confidence interval for the intercept is -0.1531 and the upper limit is 1.2080.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	SedSulfide
Count	10	10
Mean	0.4104	83.8000
Standard Deviation	0.4991	59.5964
Minimum	0.0000	30.0000
Maximum	1.3180	190.0000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:52:03 PM

Database

Y = Asin_sqrtSurvival X = SedSulfide

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.5275	-0.0014
Lower 95% Confidence Limit	-0.1531	-0.0081
Upper 95% Confidence Limit	1.2080	0.0053
Standard Error	0.2951	0.0029
Standardized Coefficient	0.0000	-0.1668
T Value	1.7872	-0.4784
Prob Level (T Test)	0.1117	0.6451
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.3503	0.0708
Regression of Y on X	0.5275	-0.0014
Inverse Regression from X on Y	4.6182	-0.0502
Orthogonal Regression of Y and X	0.5275	-0.0014

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.527450922241409) + (-1.39678904822684E-03) * (SedSulfide)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	6.236551E-02	6.236551E-02	0.2289	0.6451	0.0708
Error	8	2.179553	0.2724441			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

s = Square Root(0.2724441) = 0.5219618

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:52:03 PM

Database

Y = Asin_sqrtSurvival X = SedSulfide

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.7798	0.008242	No
Anderson Darling	1.0150	0.011311	No
D'Agostino Skewness	1.9904	0.046552	No
D'Agostino Kurtosis	0.6949	0.487115	Yes
D'Agostino Omnibus	4.4444	0.108370	No
Constant Residual Variance?			
Modified Levene Test	1.5247	0.251945	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

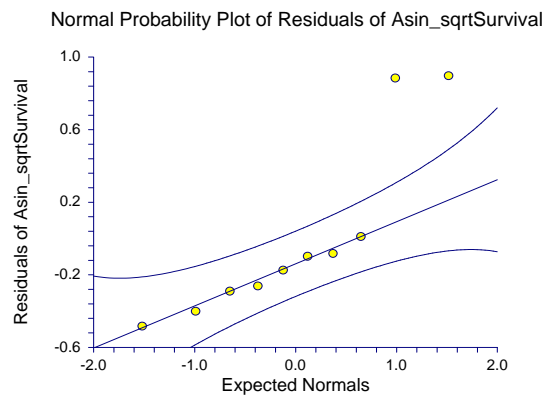
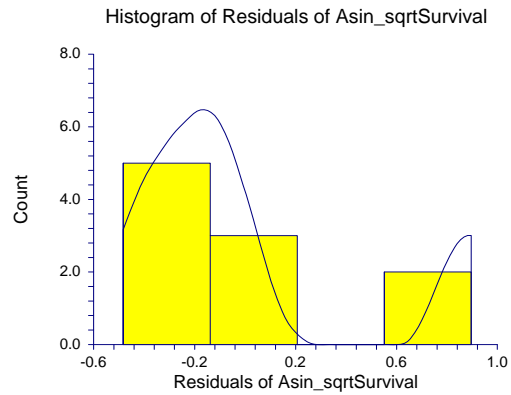
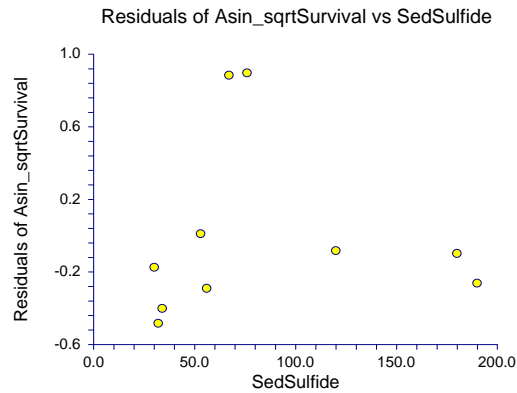
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 2:52:03 PM
Database
Y = Asin_sqrtSurvival X = SedSulfide

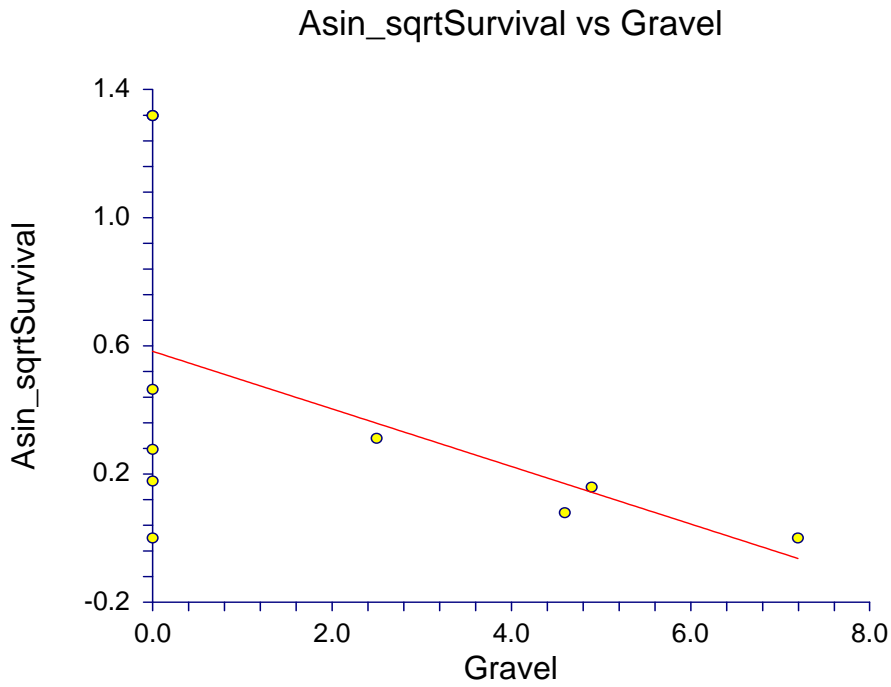
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 2:52:54 PM
Database
Y = Asin_sqrtSurvival X = Gravel

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Gravel	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.5827	Rows Prediction Only	0
Slope	-0.0898	Sum of Frequencies	10
R-Squared	0.2386	Sum of Weights	10.0000
Correlation	-0.4885	Coefficient of Variation	1.1255
Mean Square Error	0.2133725	Square Root of MSE	0.4619226

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:52:54 PM
Y = Asin_sqrtSurvival X = Gravel

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Gravel is estimated as:
 $\text{Asin_sqrtSurvival} = (0.5827) + (-0.0898) \text{ Gravel}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Gravel is zero, is 0.5827 with a standard error of 0.1822. The slope, the estimated change in Asin_sqrtSurvival per unit change in Gravel, is -0.0898 with a standard error of 0.0567. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Gravel, is 0.2386. The correlation between Asin_sqrtSurvival and Gravel is -0.4885.

A significance test that the slope is zero resulted in a t-value of -1.5834. The significance level of this t-test is 0.1520. Since $0.1520 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0898. The lower limit of the 95% confidence interval for the slope is -0.2205 and the upper limit is 0.0410. The estimated intercept is 0.5827. The lower limit of the 95% confidence interval for the intercept is 0.1627 and the upper limit is 1.0028.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Gravel
Count	10	10
Mean	0.4104	1.9200
Standard Deviation	0.4991	2.7161
Minimum	0.0000	0.0000
Maximum	1.3180	7.2000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:52:54 PM

Database

Y = Asin_sqrtSurvival X = Gravel

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.5827	-0.0898
Lower 95% Confidence Limit	0.1627	-0.2205
Upper 95% Confidence Limit	1.0028	0.0410
Standard Error	0.1822	0.0567
Standardized Coefficient	0.0000	-0.4885
T Value	3.1990	-1.5834
Prob Level (T Test)	0.0126	0.1520
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.7995	0.2870
Regression of Y on X	0.5827	-0.0898
Inverse Regression from X on Y	1.1327	-0.3762
Orthogonal Regression of Y and X	0.5872	-0.0921

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.58273847822158) + (-8.97596240737394E-02) * (Gravel)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.5349386	0.5349386	2.5071	0.1520	0.2870
Error	8	1.70698	0.2133725			
Lack of Fit	3	1.536026E-02	5.120088E-03	0.0151	0.9971	
Pure Error	5	1.69162	0.3383239			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

s = Square Root(0.2133725) = 0.4619226

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:52:54 PM

Database

Y = Asin_sqrtSurvival X = Gravel

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8843	0.146274	No
Anderson Darling	0.5582	0.149484	No
D'Agostino Skewness	1.2455	0.212931	Yes
D'Agostino Kurtosis	0.2971	0.766392	Yes
D'Agostino Omnibus	1.6397	0.440508	Yes
Constant Residual Variance?			
Modified Levene Test	2.0000	0.195014	No
Relationship is a Straight Line?			
Lack of Linear Fit F(3, 5) Test	0.0151	0.997125	Yes

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

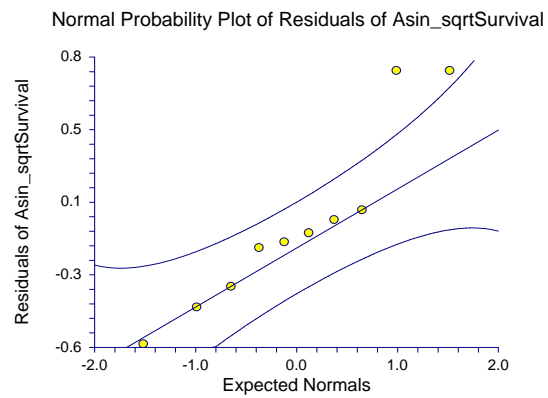
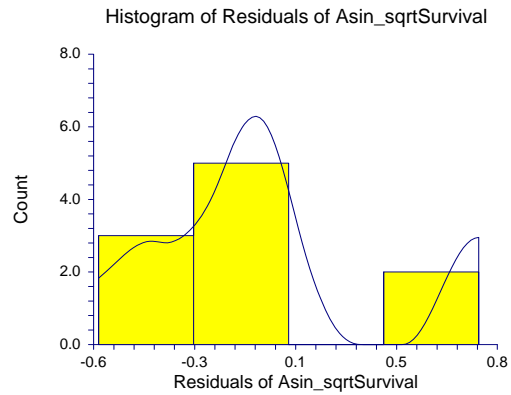
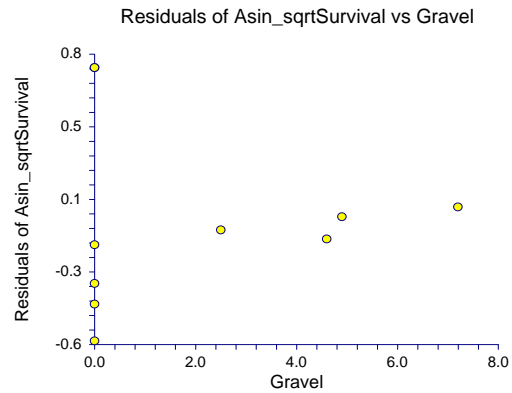
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 2:52:54 PM
Database
Y = Asin_sqrtSurvival X = Gravel

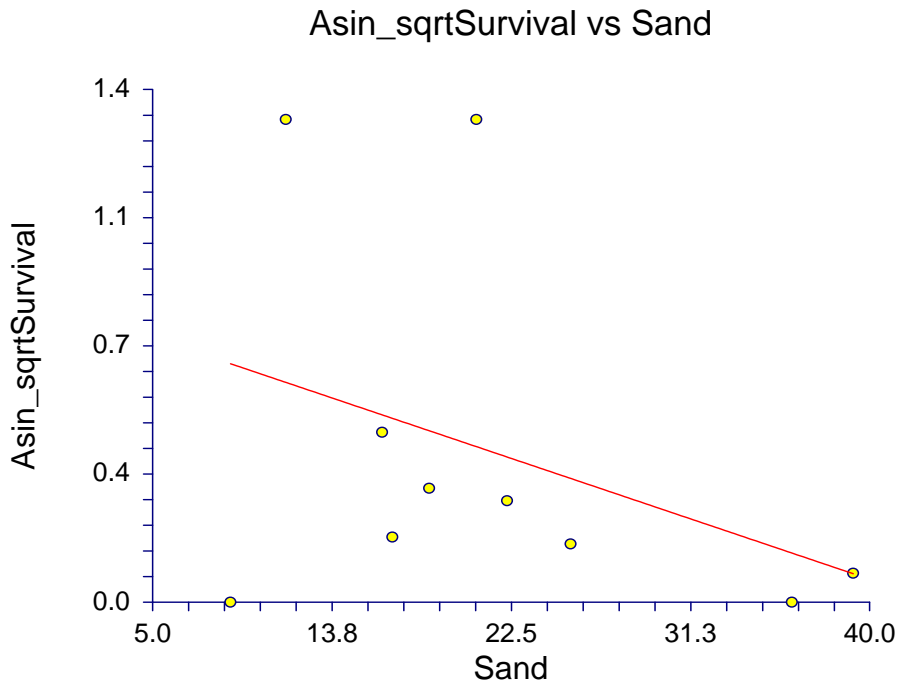
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/17/2009 2:53:11 PM
Database
Y = Asin_sqrtSurvival X = Sand

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Sand	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.8171	Rows Prediction Only	0
Slope	-0.0189	Sum of Frequencies	10
R-Squared	0.1376	Sum of Weights	10.0000
Correlation	-0.3710	Coefficient of Variation	1.1979
Mean Square Error	0.2416775	Square Root of MSE	0.491607

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:53:11 PM
Y = Asin_sqrtSurvival X = Sand

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Sand is estimated as:
 $\text{Asin_sqrtSurvival} = (0.8171) + (-0.0189) \text{ Sand}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Sand is zero, is 0.8171 with a standard error of 0.3921. The slope, the estimated change in Asin_sqrtSurvival per unit change in Sand, is -0.0189 with a standard error of 0.0167. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Sand, is 0.1376. The correlation between Asin_sqrtSurvival and Sand is -0.3710.

A significance test that the slope is zero resulted in a t-value of -1.1298. The significance level of this t-test is 0.2913. Since $0.2913 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0189. The lower limit of the 95% confidence interval for the slope is -0.0574 and the upper limit is 0.0196. The estimated intercept is 0.8171. The lower limit of the 95% confidence interval for the intercept is -0.0871 and the upper limit is 1.7212.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Sand
Count	10	10
Mean	0.4104	21.5600
Standard Deviation	0.4991	9.8155
Minimum	0.0000	8.8000
Maximum	1.3180	39.2000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:53:11 PM

Database

Y = Asin_sqrtSurvival X = Sand

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.8171	-0.0189
Lower 95% Confidence Limit	-0.0871	-0.0574
Upper 95% Confidence Limit	1.7212	0.0196
Standard Error	0.3921	0.0167
Standardized Coefficient	0.0000	-0.3710
T Value	2.0839	-1.1298
Prob Level (T Test)	0.0707	0.2913
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.4498	0.1697
Regression of Y on X	0.8171	-0.0189
Inverse Regression from X on Y	3.3657	-0.1371
Orthogonal Regression of Y and X	0.8180	-0.0189

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.817067811934901) + (-1.88621434107097E-02) * (Sand)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.3084987	0.3084987	1.2765	0.2913	0.1697
Error	8	1.93342	0.2416775			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

s = Square Root(0.2416775) = 0.491607

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:53:11 PM

Database

Y = Asin_sqrtSurvival X = Sand

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8494	0.057084	No
Anderson Darling	0.8428	0.030063	No
D'Agostino Skewness	1.5524	0.120568	No
D'Agostino Kurtosis	0.7926	0.428015	Yes
D'Agostino Omnibus	3.0381	0.218917	Yes
Constant Residual Variance?			
Modified Levene Test	0.1216	0.736286	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

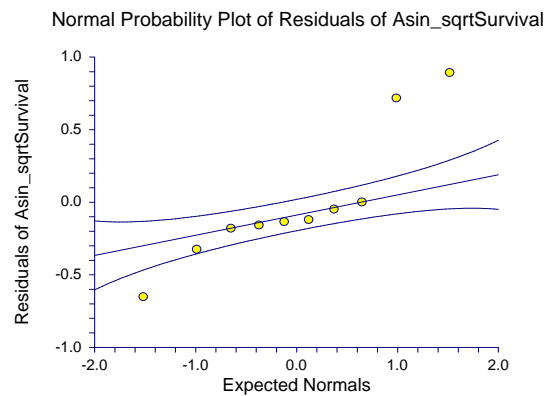
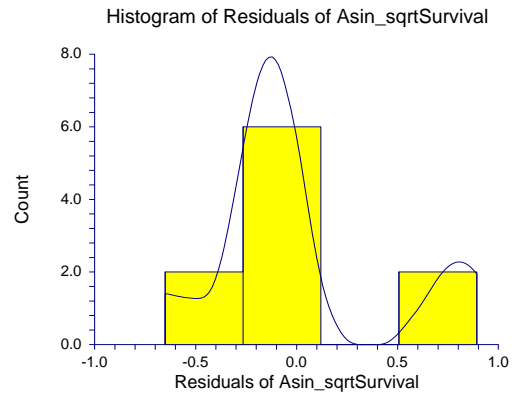
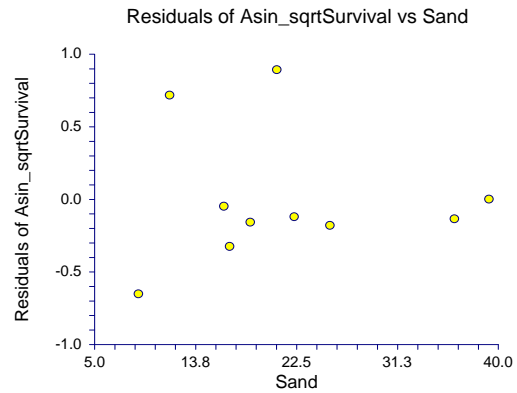
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:53:11 PM

Database

Y = Asin_sqrtSurvival X = Sand

Residual Plots Section



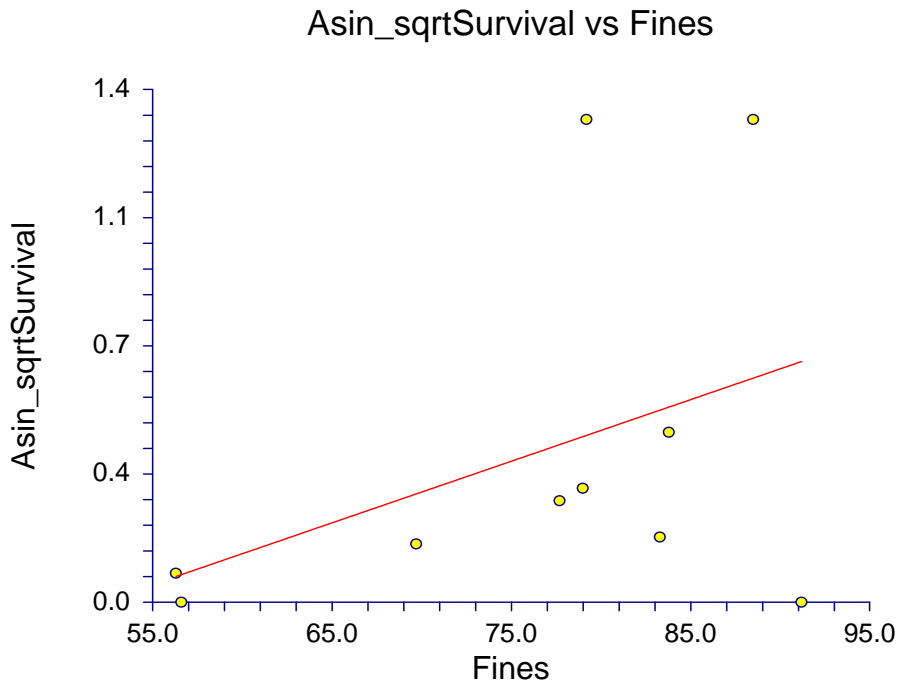
Linear Regression Report

Page/Date/Time 1 8/17/2009 2:53:26 PM

Database

Y = Asin_sqrtSurvival X = Fines

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Fines	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	-0.8767	Rows Prediction Only	0
Slope	0.0168	Sum of Frequencies	10
R-Squared	0.1672	Sum of Weights	10.0000
Correlation	0.4088	Coefficient of Variation	1.1772
Mean Square Error	0.2333972	Square Root of MSE	0.483112

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:53:26 PM

Y = Asin_sqrtSurvival X = Fines

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Fines is estimated as:
 $\text{Asin_sqrtSurvival} = (-0.8767) + (0.0168) \text{ Fines}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Fines is zero, is -0.8767 with a standard error of 1.0272. The slope, the estimated change in Asin_sqrtSurvival per unit change in Fines, is 0.0168 with a standard error of 0.0133. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Fines, is 0.1672. The correlation between Asin_sqrtSurvival and Fines is 0.4088.

A significance test that the slope is zero resulted in a t-value of 1.2671. The significance level of this t-test is 0.2408. Since $0.2408 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0168. The lower limit of the 95% confidence interval for the slope is -0.0138 and the upper limit is 0.0474. The estimated intercept is -0.8767. The lower limit of the 95% confidence interval for the intercept is -3.2454 and the upper limit is 1.4920.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Fines
Count	10	10
Mean	0.4104	76.5300
Standard Deviation	0.4991	12.1330
Minimum	0.0000	56.3000
Maximum	1.3180	91.2000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:53:26 PM

Database

Y = Asin_sqrtSurvival X = Fines

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-0.8767	0.0168
Lower 95% Confidence Limit	-3.2454	-0.0138
Upper 95% Confidence Limit	1.4920	0.0474
Standard Error	1.0272	0.0133
Standardized Coefficient	0.0000	0.4088
T Value	-0.8535	1.2671
Prob Level (T Test)	0.4182	0.2408
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.1174	0.2013
Regression of Y on X	-0.8767	0.0168
Inverse Regression from X on Y	-7.2897	0.1006
Orthogonal Regression of Y and X	-0.8785	0.0168

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(-0.876689126797058) + (1.68180991349413E-02) * (\text{Fines})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	0.3747405	0.3747405	1.6056	0.2408	0.2013
Error	8	1.867178	0.2333972			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

$s = \text{Square Root}(0.2333972) = 0.483112$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:53:26 PM

Database

Y = Asin_sqrtSurvival X = Fines

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8560	0.068426	No
Anderson Darling	0.8183	0.034546	No
D'Agostino Skewness	1.4278	0.153347	No
D'Agostino Kurtosis	0.7398	0.459421	Yes
D'Agostino Omnibus	2.5859	0.274454	Yes

Constant Residual Variance?

Modified Levene Test	7.5475	0.025165	No
----------------------	--------	----------	----

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

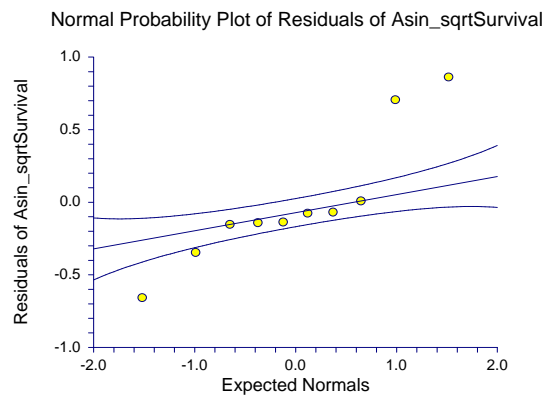
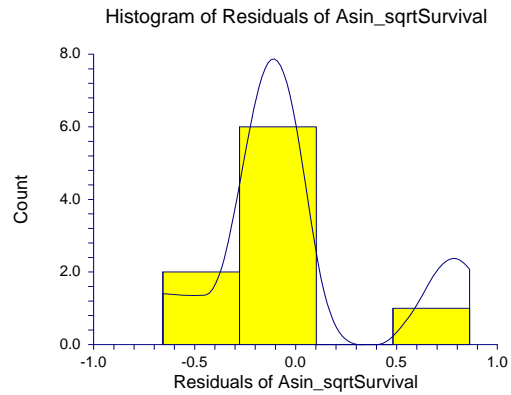
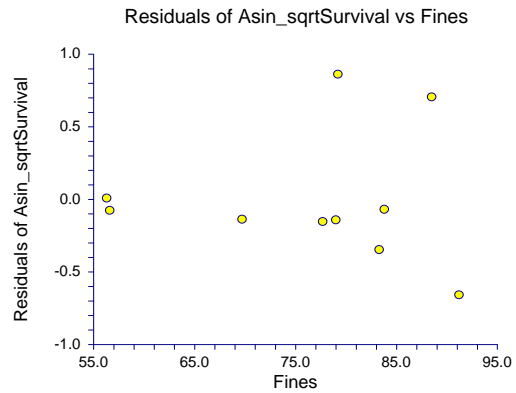
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/17/2009 2:53:26 PM
Database
Y = Asin_sqrtSurvival X = Fines

Residual Plots Section



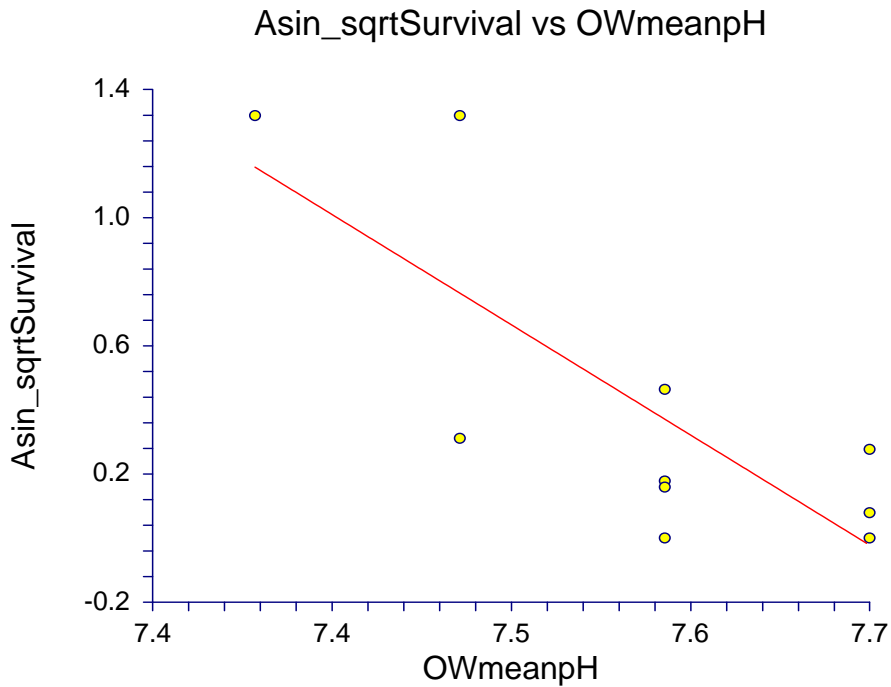
Linear Regression Report

Page/Date/Time 1 9/18/2009 10:16:23 AM

Database

Y = Asin_sqrtSurvival X = OWmeanpH

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	OWmeanpH	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	30.2468	Rows Prediction Only	0
Slope	-3.9310	Sum of Frequencies	10
R-Squared	0.6134	Sum of Weights	10.0000
Correlation	-0.7832	Coefficient of Variation	0.8020
Mean Square Error	0.1083269	Square Root of MSE	0.3291304

Linear Regression Report

Page/Date/Time 2 9/18/2009 10:16:23 AM
Y = Asin_sqrtSurvival X = OWmeanpH

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and OWmeanpH is estimated as:
 $\text{Asin_sqrtSurvival} = (30.2468) + (-3.9310) \text{ OWmeanpH}$ using the 10 observations in this dataset.
The y-intercept, the estimated value of Asin_sqrtSurvival when OWmeanpH is zero, is 30.2468 with a standard error of 8.3743. The slope, the estimated change in Asin_sqrtSurvival per unit change in OWmeanpH, is -3.9310 with a standard error of 1.1032. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in OWmeanpH, is 0.6134. The correlation between Asin_sqrtSurvival and OWmeanpH is -0.7832.

A significance test that the slope is zero resulted in a t-value of -3.5631. The significance level of this t-test is 0.0074. Since $0.0074 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is -3.9310. The lower limit of the 95% confidence interval for the slope is -6.4751 and the upper limit is -1.3869. The estimated intercept is 30.2468. The lower limit of the 95% confidence interval for the intercept is 10.9356 and the upper limit is 49.5579.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	OWmeanpH
Count	10	10
Mean	0.4104	7.5900
Standard Deviation	0.4991	0.0994
Minimum	0.0000	7.4000
Maximum	1.3180	7.7000

Linear Regression Report

Page/Date/Time 3 9/18/2009 10:16:23 AM

Database

Y = Asin_sqrtSurvival X = OWmeanpH

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	30.2468	-3.9310
Lower 95% Confidence Limit	10.9356	-6.4751
Upper 95% Confidence Limit	49.5579	-1.3869
Standard Error	8.3743	1.1032
Standardized Coefficient	0.0000	-0.7832
T Value	3.6119	-3.5631
Prob Level (T Test)	0.0069	0.0074
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	0.8840	0.8756
Regression of Y on X	30.2468	-3.9310
Inverse Regression from X on Y	49.0475	-6.4080
Orthogonal Regression of Y and X	48.3191	-6.3121

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(30.246775280942) + (-3.93101123596075) * (OWmeanpH)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	1.375304	1.375304	12.6959	0.0074	0.8756
Error	8	0.8666148	0.1083269			
Lack of Fit	2	0.2070049	0.1035024	0.9415	0.4409	
Pure Error	6	0.6596099	0.109935			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

s = Square Root(0.1083269) = 0.3291304

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/18/2009 10:16:23 AM

Database

Y = Asin_sqrtSurvival X = OWmeanpH

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9704	0.894480	Yes
Anderson Darling	0.1986	0.886253	Yes
D'Agostino Skewness	0.2920	0.770279	Yes
D'Agostino Kurtosis	-0.1381	0.890184	Yes
D'Agostino Omnibus	0.1043	0.949170	Yes
Constant Residual Variance?			
Modified Levene Test	0.4247	0.532865	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(2, 6) Test	0.9415	0.440944	Yes

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

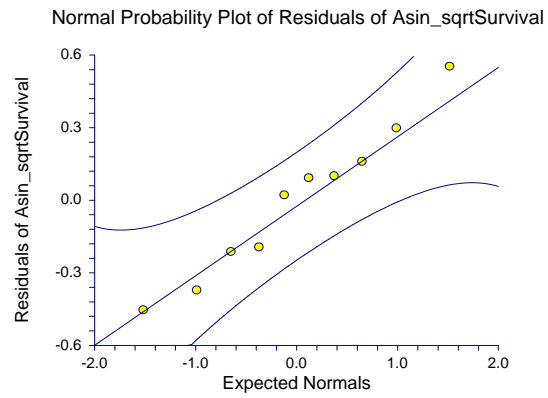
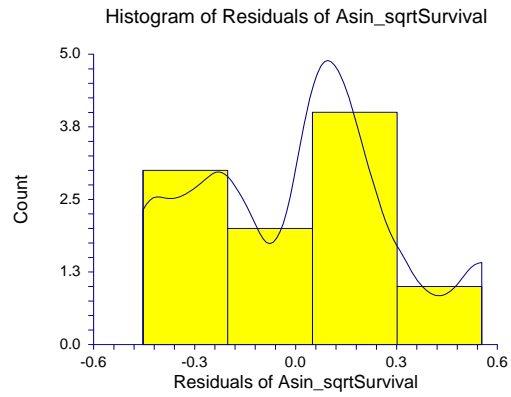
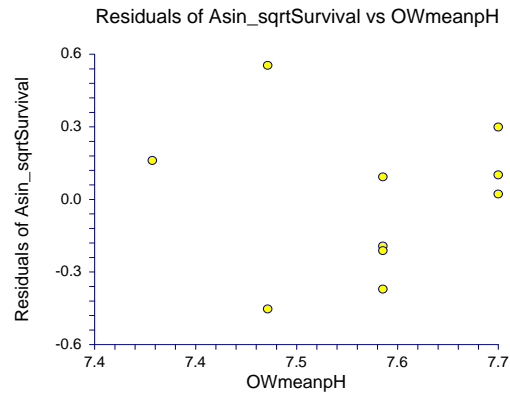
Linear Regression Report

Page/Date/Time 5 9/18/2009 10:16:23 AM

Database

Y = Asin_sqrtSurvival X = OWmeanpH

Residual Plots Section



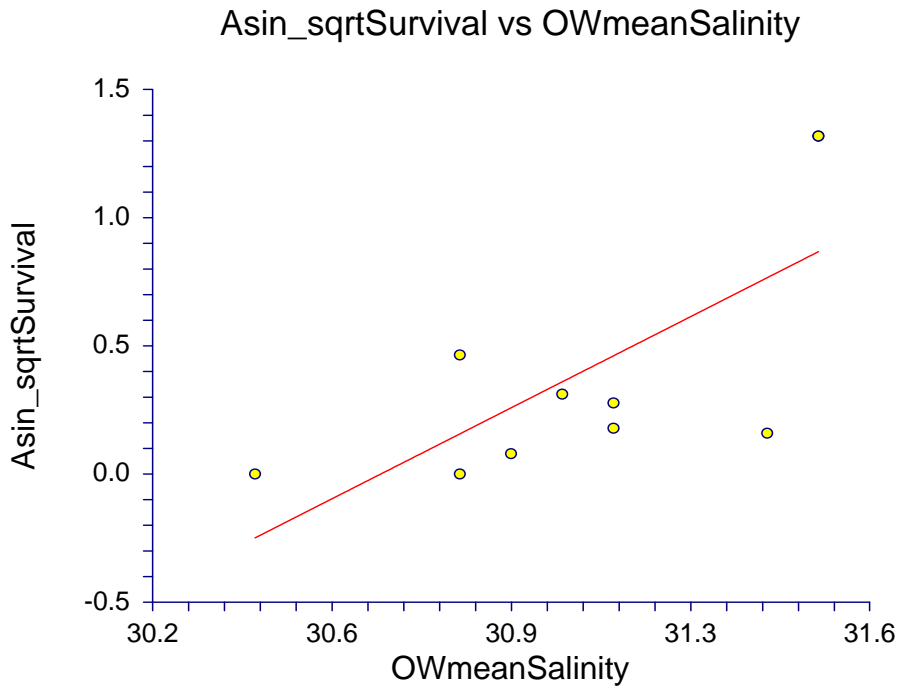
Linear Regression Report

Page/Date/Time 1 9/18/2009 10:16:39 AM

Database

Y = Asin_sqrtSurvival X = OWmeanSalinity

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	OWmeanSalinity	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	-31.0948	Rows Prediction Only	0
Slope	1.0147	Sum of Frequencies	10
R-Squared	0.5074	Sum of Weights	10.0000
Correlation	0.7123	Coefficient of Variation	0.9053
Mean Square Error	0.1380351	Square Root of MSE	0.3715308

Linear Regression Report

Page/Date/Time 2 9/18/2009 10:16:39 AM
Y = Asin_sqrtSurvival X = OWmeanSalinity

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and OWmeanSalinity is estimated as: $\text{Asin_sqrtSurvival} = (-31.0948) + (1.0147) \text{OWmeanSalinity}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when OWmeanSalinity is zero, is -31.0948 with a standard error of 10.9749. The slope, the estimated change in Asin_sqrtSurvival per unit change in OWmeanSalinity, is 1.0147 with a standard error of 0.3534. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in OWmeanSalinity, is 0.5074. The correlation between Asin_sqrtSurvival and OWmeanSalinity is 0.7123.

A significance test that the slope is zero resulted in a t-value of 2.8708. The significance level of this t-test is 0.0208. Since $0.0208 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is 1.0147. The lower limit of the 95% confidence interval for the slope is 0.1996 and the upper limit is 1.8297. The estimated intercept is -31.0948. The lower limit of the 95% confidence interval for the intercept is -56.4030 and the upper limit is -5.7867.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	OWmeanSalinity
Count	10	10
Mean	0.4104	31.0500
Standard Deviation	0.4991	0.3504
Minimum	0.0000	30.4000
Maximum	1.3180	31.5000

Linear Regression Report

Page/Date/Time 3 9/18/2009 10:16:39 AM

Database

Y = Asin_sqrtSurvival X = OWmeanSalinity

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-31.0948	1.0147
Lower 95% Confidence Limit	-56.4030	0.1996
Upper 95% Confidence Limit	-5.7867	1.8297
Standard Error	10.9749	0.3534
Standardized Coefficient	0.0000	0.7123
T Value	-2.8333	2.8708
Prob Level (T Test)	0.0220	0.0208
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	0.6999	0.7111
Regression of Y on X	-31.0948	1.0147
Inverse Regression from X on Y	-61.6763	1.9996
Orthogonal Regression of Y and X	-50.1451	1.6282

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(-31.0948126697067) + (1.01466063348492) * (\text{OWmeanSalinity})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	1.137637	1.137637	8.2417	0.0208	0.7111
Error	8	1.104281	0.1380351			
Lack of Fit	5	0.9917324	0.1983465	5.2870	0.1005	
Pure Error	3	0.1125485	3.751617E-02			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

$s = \text{Square Root}(0.1380351) = 0.3715308$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/18/2009 10:16:39 AM

Database

Y = Asin_sqrtSurvival X = OWmeanSalinity

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9247	0.397501	Yes
Anderson Darling	0.3832	0.396655	Yes
D'Agostino Skewness	-0.1650	0.868913	Yes
D'Agostino Kurtosis	-0.5948	0.552006	Yes
D'Agostino Omnibus	0.3810	0.826556	Yes
Constant Residual Variance?			
Modified Levene Test	1.4778	0.258768	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(5, 3) Test	5.2870	0.100529	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

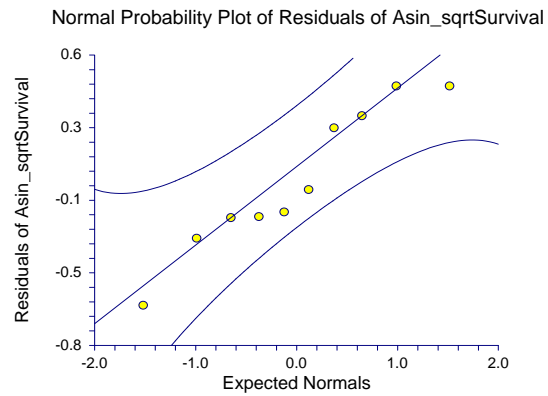
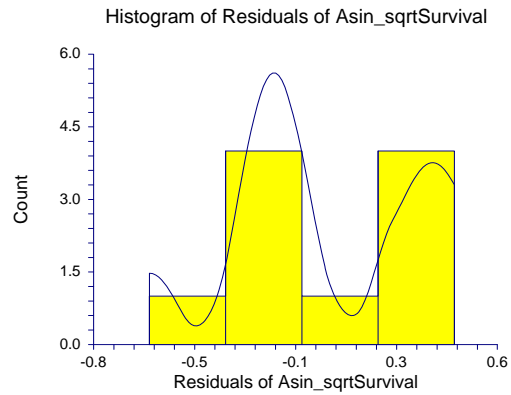
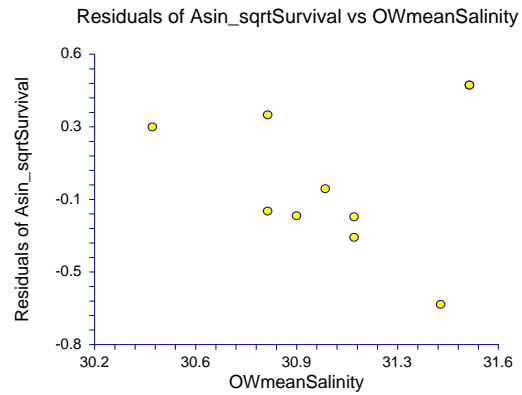
Linear Regression Report

Page/Date/Time 5 9/18/2009 10:16:39 AM

Database

Y = Asin_sqrtSurvival X = OWmeanSalinity

Residual Plots Section



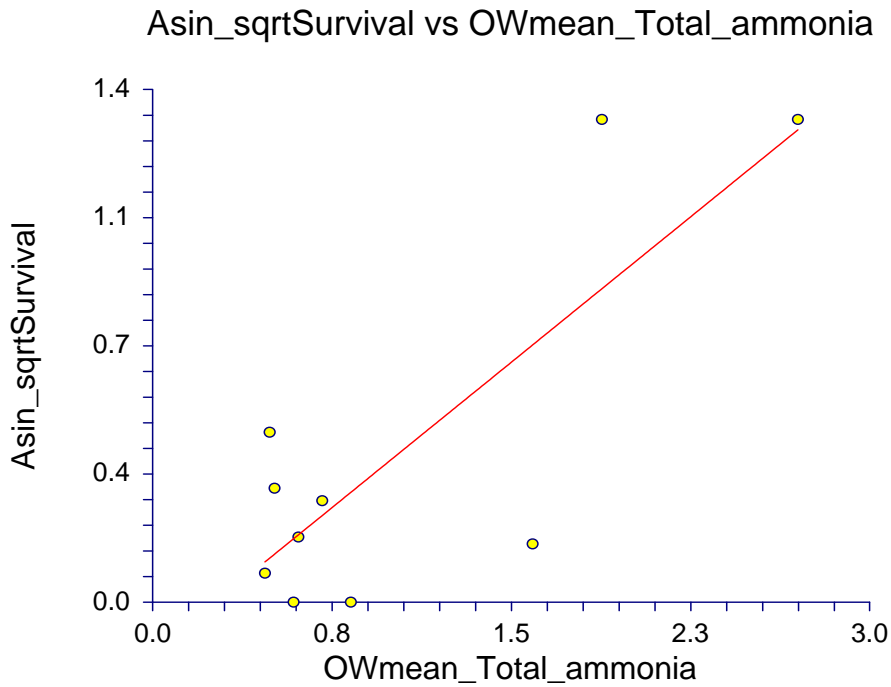
Linear Regression Report

Page/Date/Time 1 9/18/2009 10:16:52 AM

Database

Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	OWmean_Total_ammonia	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	-0.1388	Rows Prediction Only	0
Slope	0.5291	Sum of Frequencies	10
R-Squared	0.6508	Sum of Weights	10.0000
Correlation	0.8067	Coefficient of Variation	0.7623
Mean Square Error	9.786985E-02	Square Root of MSE	0.3128416

Linear Regression Report

Page/Date/Time 2 9/18/2009 10:16:52 AM

Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and OWmean_Total_ammonia is estimated as: $\text{Asin_sqrtSurvival} = (-0.1388) + (0.5291) \text{OWmean_Total_ammonia}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when OWmean_Total_ammonia is zero, is -0.1388 with a standard error of 0.1733. The slope, the estimated change in Asin_sqrtSurvival per unit change in OWmean_Total_ammonia, is 0.5291 with a standard error of 0.1370. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in OWmean_Total_ammonia, is 0.6508. The correlation between Asin_sqrtSurvival and OWmean_Total_ammonia is 0.8067.

A significance test that the slope is zero resulted in a t-value of 3.8610. The significance level of this t-test is 0.0048. Since $0.0048 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is 0.5291. The lower limit of the 95% confidence interval for the slope is 0.2131 and the upper limit is 0.8450. The estimated intercept is -0.1388. The lower limit of the 95% confidence interval for the intercept is -0.5383 and the upper limit is 0.2608.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	OWmean_Total_ammonia
Count	10	10
Mean	0.4104	1.0380
Standard Deviation	0.4991	0.7610
Minimum	0.0000	0.4700
Maximum	1.3180	2.7000

Linear Regression Report

Page/Date/Time 3 9/18/2009 10:16:52 AM

Database

Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-0.1388	0.5291
Lower 95% Confidence Limit	-0.5383	0.2131
Upper 95% Confidence Limit	0.2608	0.8450
Standard Error	0.1733	0.1370
Standardized Coefficient	0.0000	0.8067
T Value	-0.8009	3.8610
Prob Level (T Test)	0.4463	0.0048
Reject H0 (Alpha = 0.0500)	No	Yes
Power (Alpha = 0.0500)	0.1092	0.9206
Regression of Y on X	-0.1388	0.5291
Inverse Regression from X on Y	-0.4335	0.8130
Orthogonal Regression of Y and X	-0.2095	0.5972

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(-0.138763646409688) + (0.529059389604709) * (\text{OWmean_Total_ammonia})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.684282	1.684282			
Slope	1	1.45896	1.45896	14.9071	0.0048	0.9206
Error	8	0.7829588	9.786985E-02			
Adj. Total	9	2.241918	0.249102			
Total	10	3.9262				

$s = \text{Square Root}(9.786985\text{E-}02) = 0.3128416$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/18/2009 10:16:52 AM

Database

Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9769	0.946284	Yes
Anderson Darling	0.1976	0.887626	Yes
D'Agostino Skewness	-0.3888	0.697391	Yes
D'Agostino Kurtosis	0.3424	0.732027	Yes
D'Agostino Omnibus	0.2685	0.874389	Yes
Constant Residual Variance?			
Modified Levene Test	0.8987	0.370872	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

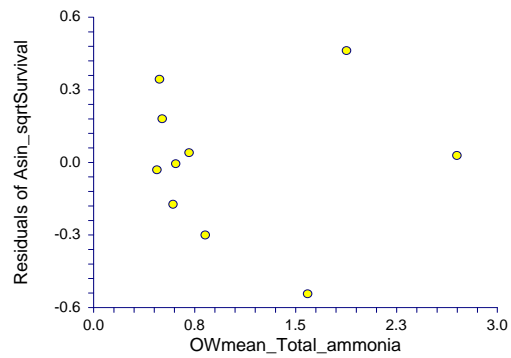
Page/Date/Time 5 9/18/2009 10:16:52 AM

Database

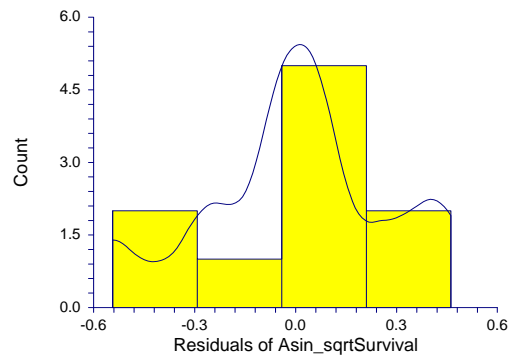
Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Residual Plots Section

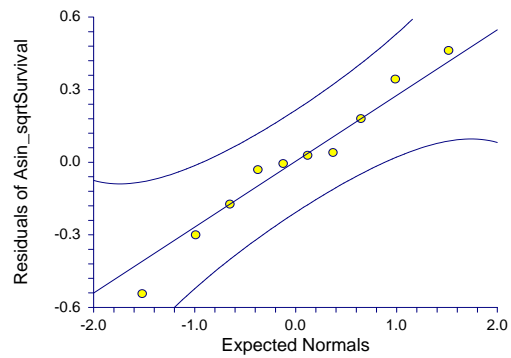
Residuals of Asin_sqrtSurvival vs OWmean_Total_ammonia



Histogram of Residuals of Asin_sqrtSurvival



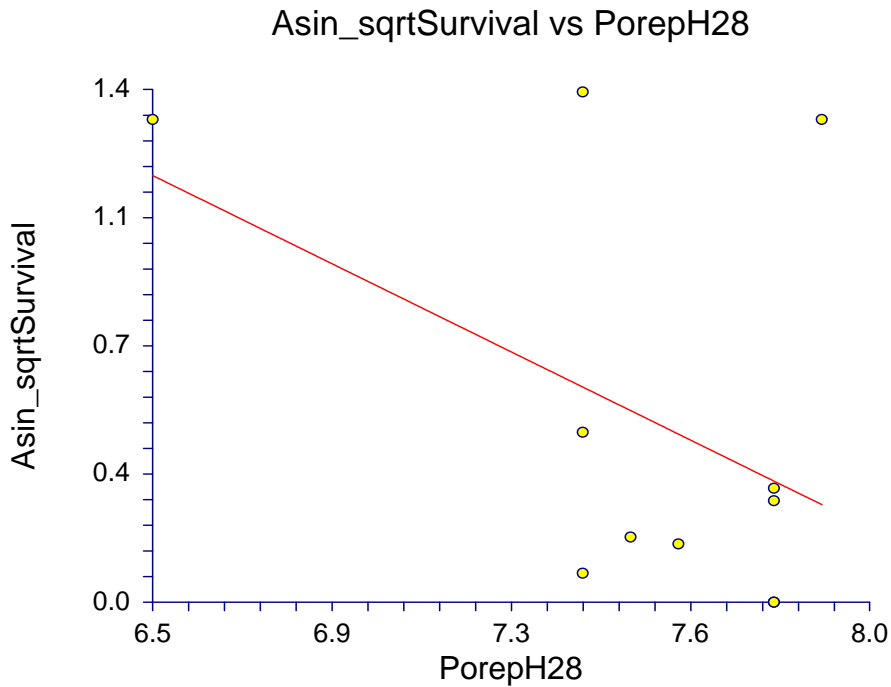
Normal Probability Plot of Residuals of Asin_sqrtSurvival



Linear Regression Report

Page/Date/Time 1 8/17/2009 2:57:44 PM
Database
Y = Asin_sqrtSurvival X = PorepH28

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	PorepH28	Rows Used in Estimation	11
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	5.3371	Rows Prediction Only	0
Slope	-0.6419	Sum of Frequencies	11
R-Squared	0.2041	Sum of Weights	11.0000
Correlation	-0.4518	Coefficient of Variation	1.0511
Mean Square Error	0.2758792	Square Root of MSE	0.525242

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:57:44 PM
Y = Asin_sqrtSurvival X = PorepH28

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and PorepH28 is estimated as:
 $\text{Asin_sqrtSurvival} = (5.3371) + (-0.6419) \text{PorepH28}$ using the 11 observations in this dataset.
The y-intercept, the estimated value of Asin_sqrtSurvival when PorepH28 is zero, is 5.3371 with a standard error of 3.1881. The slope, the estimated change in Asin_sqrtSurvival per unit change in PorepH28, is -0.6419 with a standard error of 0.4225. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in PorepH28, is 0.2041. The correlation between Asin_sqrtSurvival and PorepH28 is -0.4518.

A significance test that the slope is zero resulted in a t-value of -1.5192. The significance level of this t-test is 0.1630. Since $0.1630 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.6419. The lower limit of the 95% confidence interval for the slope is -1.5976 and the upper limit is 0.3139. The estimated intercept is 5.3371. The lower limit of the 95% confidence interval for the intercept is -1.8748 and the upper limit is 12.5491.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	PorepH28
Count	11	11
Mean	0.4997	7.5364
Standard Deviation	0.5585	0.3931
Minimum	0.0000	6.5000
Maximum	1.3930	7.9000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:57:44 PM

Database

Y = Asin_sqrtSurvival X = PorepH28

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	5.3371	-0.6419
Lower 95% Confidence Limit	-1.8748	-1.5976
Upper 95% Confidence Limit	12.5491	0.3139
Standard Error	3.1881	0.4225
Standardized Coefficient	0.0000	-0.4518
T Value	1.6741	-1.5192
Prob Level (T Test)	0.1284	0.1630
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.3221	0.2746
Regression of Y on X	5.3371	-0.6419
Inverse Regression from X on Y	24.2004	-3.1448
Orthogonal Regression of Y and X	16.1000	-2.0700

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(5.33714176470525) + (-.641876470588147) * (\text{PorepH28})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	2.747001	2.747001			
Slope	1	0.6367356	0.6367356	2.3080	0.1630	0.2746
Error	9	2.482913	0.2758792			
Lack of Fit	4	1.483278	0.3708195	1.8548	0.2565	
Pure Error	5	0.9996347	0.1999269			
Adj. Total	10	3.119648	0.3119648			
Total	11	5.866649				

$s = \text{Square Root}(0.2758792) = 0.525242$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:57:44 PM

Database

Y = Asin_sqrtSurvival X = PorepH28

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8191	0.016808	No
Anderson Darling	0.8944	0.022428	No
D'Agostino Skewness	2.0813	0.037410	No
D'Agostino Kurtosis	0.9626	0.335752	Yes
D'Agostino Omnibus	5.2583	0.072141	No

Constant Residual Variance?

Modified Levene Test	0.0009	0.976942	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(4, 5) Test	1.8548	0.256452	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

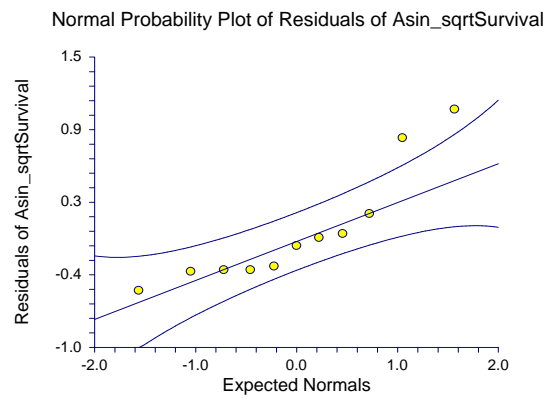
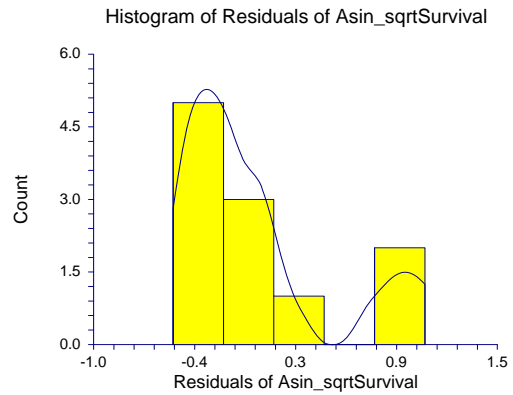
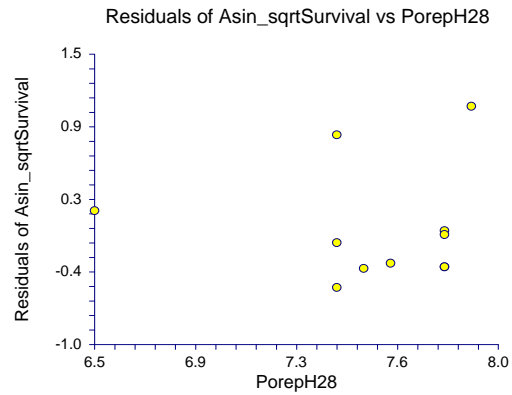
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:57:44 PM

Database

Y = Asin_sqrtSurvival X = PorepH28

Residual Plots Section



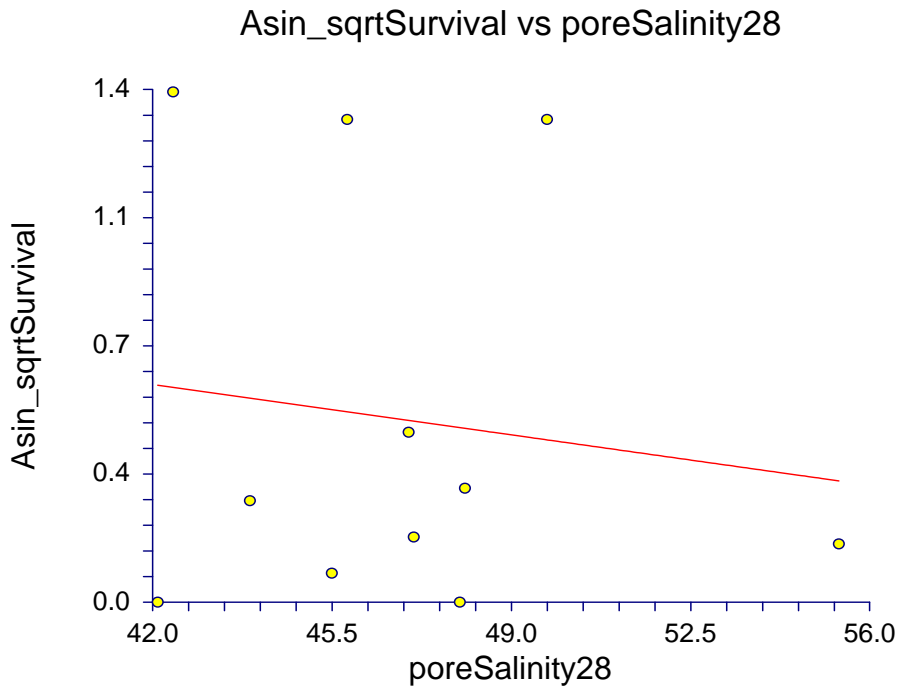
Linear Regression Report

Page/Date/Time 1 8/18/2009 7:43:45 AM

Database

Y = Asin_sqrtSurvival X = poreSalinity28

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	poreSalinity28	Rows Used in Estimation	11
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.4190	Rows Prediction Only	0
Slope	-0.0196	Sum of Frequencies	11
R-Squared	0.0171	Sum of Weights	11.0000
Correlation	-0.1307	Coefficient of Variation	1.1680
Mean Square Error	0.3407087	Square Root of MSE	0.5837026

Linear Regression Report

Page/Date/Time 2 8/18/2009 7:43:45 AM

Y = Asin_sqrtSurvival X = poreSalinity28

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and poreSalinity28 is estimated as: $\text{Asin_sqrtSurvival} = (1.4190) + (-0.0196) \text{poreSalinity28}$ using the 11 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when poreSalinity28 is zero, is 1.4190 with a standard error of 2.3315. The slope, the estimated change in Asin_sqrtSurvival per unit change in poreSalinity28, is -0.0196 with a standard error of 0.0497. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in poreSalinity28, is 0.0171. The correlation between Asin_sqrtSurvival and poreSalinity28 is -0.1307.

A significance test that the slope is zero resulted in a t-value of -0.3954. The significance level of this t-test is 0.7017. Since $0.7017 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0196. The lower limit of the 95% confidence interval for the slope is -0.1320 and the upper limit is 0.0927. The estimated intercept is 1.4190. The lower limit of the 95% confidence interval for the intercept is -3.8552 and the upper limit is 6.6931.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	poreSalinity28
Count	11	11
Mean	0.4997	46.8182
Standard Deviation	0.5585	3.7172
Minimum	0.0000	42.1000
Maximum	1.3930	55.4000

Linear Regression Report

Page/Date/Time 3 8/18/2009 7:43:45 AM

Database

Y = Asin_sqrtSurvival X = poreSalinity28

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.4190	-0.0196
Lower 95% Confidence Limit	-3.8552	-0.1320
Upper 95% Confidence Limit	6.6931	0.0927
Standard Error	2.3315	0.0497
Standardized Coefficient	0.0000	-0.1307
T Value	0.6086	-0.3954
Prob Level (T Test)	0.5578	0.7017
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.0848	0.0646
Regression of Y on X	1.4190	-0.0196
Inverse Regression from X on Y	54.3345	-1.1499
Orthogonal Regression of Y and X	1.4398	-0.0201

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.41898619682356) + (-1.96346566311829E-02) * (poreSalinity28)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	2.747001	2.747001			
Slope	1	5.326971E-02	5.326971E-02	0.1563	0.7017	0.0646
Error	9	3.066378	0.3407087			
Adj. Total	10	3.119648	0.3119648			
Total	11	5.866649				

s = Square Root(0.3407087) = 0.5837026

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 7:43:45 AM

Database

Y = Asin_sqrtSurvival X = poreSalinity28

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8112	0.013222	No
Anderson Darling	0.9533	0.016054	No
D'Agostino Skewness	1.3676	0.171428	No
D'Agostino Kurtosis	-0.7520	0.452073	Yes
D'Agostino Omnibus	2.4359	0.295842	Yes

Constant Residual Variance?

Modified Levene Test	0.5345	0.483307	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No
---------------------------------	--------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

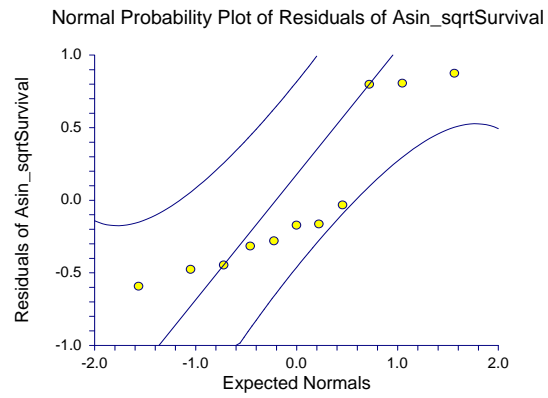
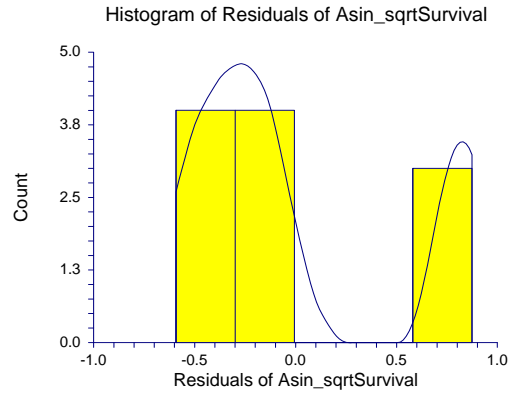
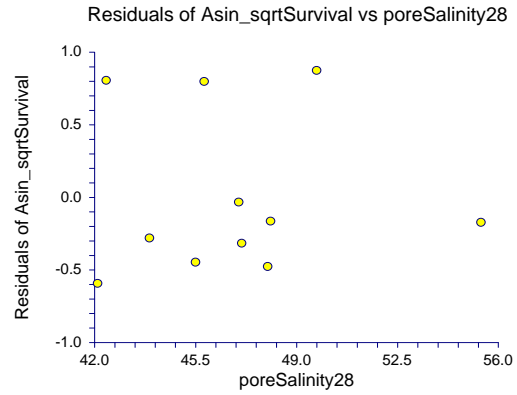
Linear Regression Report

Page/Date/Time 5 8/18/2009 7:43:45 AM

Database

Y = Asin_sqrtSurvival X = poreSalinity28

Residual Plots Section



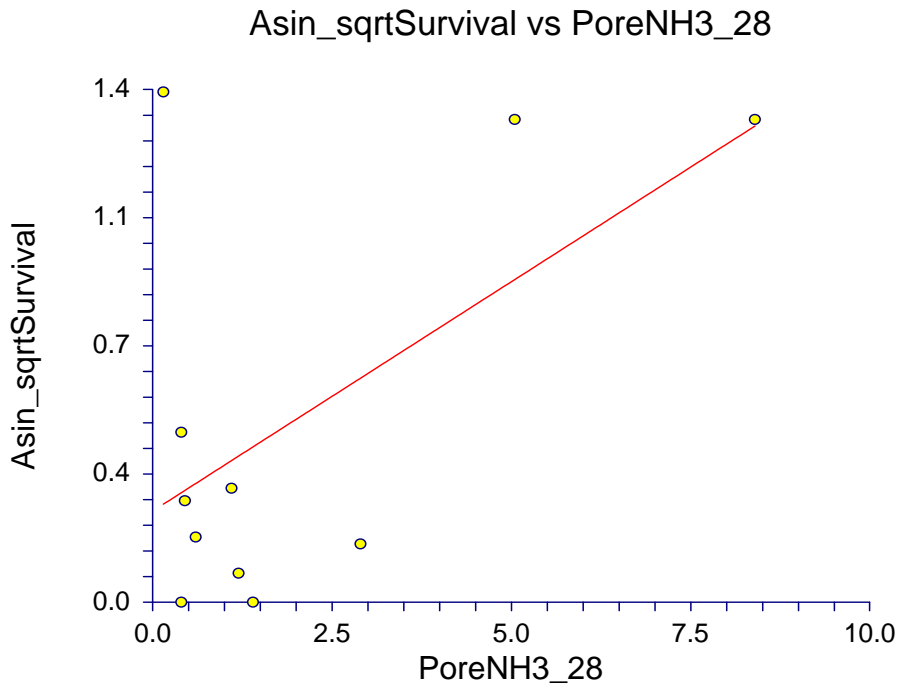
Linear Regression Report

Page/Date/Time 1 8/17/2009 2:58:02 PM

Database

Y = Asin_sqrtSurvival X = PoreNH3_28

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	PoreNH3_28	Rows Used in Estimation	11
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.2489	Rows Prediction Only	0
Slope	0.1251	Sum of Frequencies	11
R-Squared	0.3302	Sum of Weights	11.0000
Correlation	0.5746	Coefficient of Variation	0.9642
Mean Square Error	0.2321716	Square Root of MSE	0.4818419

Linear Regression Report

Page/Date/Time 2 8/17/2009 2:58:02 PM

Y = Asin_sqrtSurvival X = PoreNH3_28

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and PoreNH3_28 is estimated as:
 $\text{Asin_sqrtSurvival} = (0.2489) + (0.1251) \text{ PoreNH3_28}$ using the 11 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when PoreNH3_28 is zero, is 0.2489 with a standard error of 0.1878. The slope, the estimated change in Asin_sqrtSurvival per unit change in PoreNH3_28, is 0.1251 with a standard error of 0.0594. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in PoreNH3_28, is 0.3302. The correlation between Asin_sqrtSurvival and PoreNH3_28 is 0.5746.

A significance test that the slope is zero resulted in a t-value of 2.1064. The significance level of this t-test is 0.0644. Since $0.0644 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.1251. The lower limit of the 95% confidence interval for the slope is -0.0093 and the upper limit is 0.2595. The estimated intercept is 0.2489. The lower limit of the 95% confidence interval for the intercept is -0.1761 and the upper limit is 0.6738.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	PoreNH3_28
Count	11	11
Mean	0.4997	2.0045
Standard Deviation	0.5585	2.5649
Minimum	0.0000	0.1500
Maximum	1.3930	8.4000

Linear Regression Report

Page/Date/Time 3 8/17/2009 2:58:02 PM

Database

Y = Asin_sqrtSurvival X = PoreNH3_28

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.2489	0.1251
Lower 95% Confidence Limit	-0.1761	-0.0093
Upper 95% Confidence Limit	0.6738	0.2595
Standard Error	0.1878	0.0594
Standardized Coefficient	0.0000	0.5746
T Value	1.3250	2.1064
Prob Level (T Test)	0.2178	0.0644
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.2205	0.4686
Regression of Y on X	0.2489	0.1251
Inverse Regression from X on Y	-0.2599	0.3790
Orthogonal Regression of Y and X	0.2408	0.1292

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(.248893862449216) + (.125132313517398) * (\text{PoreNH3_28})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	2.747001	2.747001			
Slope	1	1.030103	1.030103	4.4368	0.0644	0.4686
Error	9	2.089545	0.2321716			
Lack of Fit	8	1.981897	0.2477371	2.3014	0.4717	
Pure Error	1	0.107648	0.107648			
Adj. Total	10	3.119648	0.3119648			
Total	11	5.866649				

$s = \text{Square Root}(0.2321716) = 0.4818419$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/17/2009 2:58:02 PM

Database

Y = Asin_sqrtSurvival X = PoreNH3_28

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8498	0.042439	No
Anderson Darling	0.6202	0.106501	No
D'Agostino Skewness	2.3924	0.016737	No
D'Agostino Kurtosis	1.9446	0.051819	No
D'Agostino Omnibus	9.5054	0.008628	No

Constant Residual Variance?

Modified Levene Test	0.0173	0.898187	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(8, 1) Test	2.3014	0.471709	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

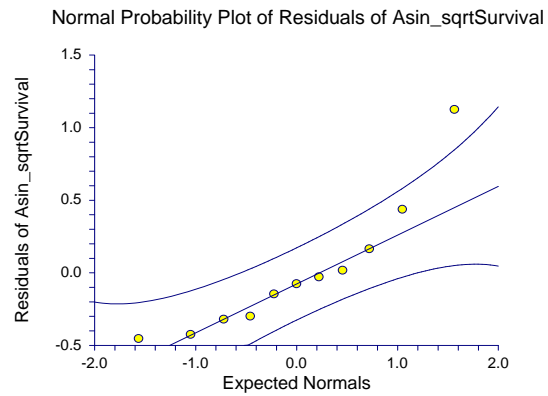
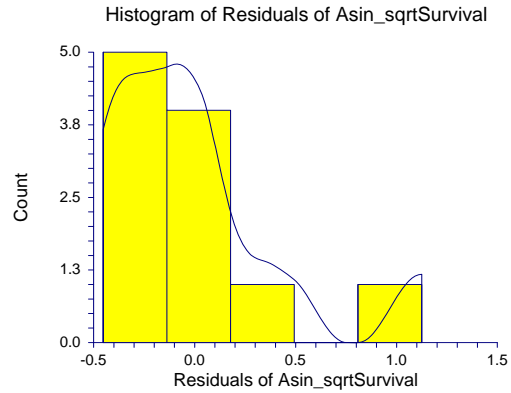
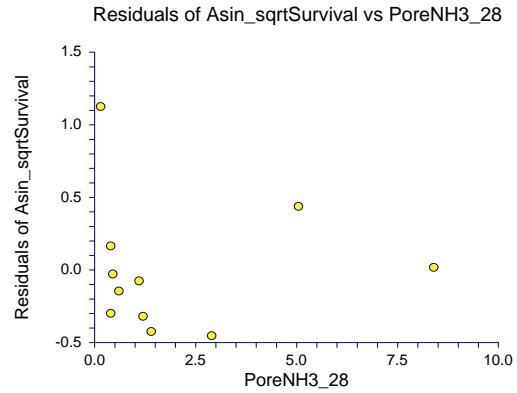
Linear Regression Report

Page/Date/Time 5 8/17/2009 2:58:02 PM

Database

Y = Asin_sqrtSurvival X = PoreNH3_28

Residual Plots Section



**ALL POSSIBLE REGRESSION AND MULTIPLE REGRESSION
REPORTS**

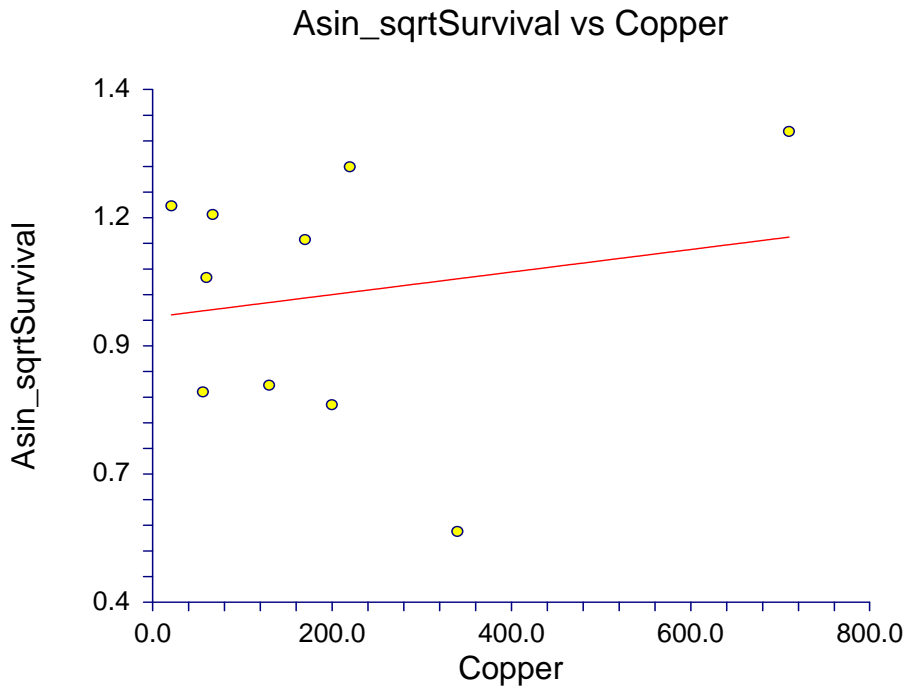
APPENDIX L
REGRESSION REPORTS FOR *NEANTHES ARENACEODENTATA*
SURVIVAL DATA

PAIR-WISE LINEAR REGRESSION REPORTS

Linear Regression Report

Page/Date/Time 1 8/18/2009 1:15:01 PM
Database
Y = Asin_sqrtSurvival X = Copper

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Copper	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.9558	Rows Prediction Only	0
Slope	0.0002	Sum of Frequencies	10
R-Squared	0.0326	Sum of Weights	10.0000
Correlation	0.1807	Coefficient of Variation	0.2597
Mean Square Error	0.0673551	Square Root of MSE	0.2595286

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:15:01 PM
Y = Asin_sqrtSurvival X = Copper

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Copper is estimated as:
 $\text{Asin_sqrtSurvival} = (0.9558) + (0.0002) \text{Copper}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Copper is zero, is 0.9558 with a standard error of 0.1171. The slope, the estimated change in Asin_sqrtSurvival per unit change in Copper, is 0.0002 with a standard error of 0.0004. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Copper, is 0.0326. The correlation between Asin_sqrtSurvival and Copper is 0.1807.

A significance test that the slope is zero resulted in a t-value of 0.5195. The significance level of this t-test is 0.6175. Since $0.6175 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0002. The lower limit of the 95% confidence interval for the slope is -0.0008 and the upper limit is 0.0012. The estimated intercept is 0.9558. The lower limit of the 95% confidence interval for the intercept is 0.6857 and the upper limit is 1.2259.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Copper
Count	10	10
Mean	0.9992	197.4000
Standard Deviation	0.2488	204.3685
Minimum	0.5380	21.0000
Maximum	1.3180	710.0000

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:15:01 PM

Database

Y = Asin_sqrtSurvival X = Copper

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.9558	0.0002
Lower 95% Confidence Limit	0.6857	-0.0008
Upper 95% Confidence Limit	1.2259	0.0012
Standard Error	0.1171	0.0004
Standardized Coefficient	0.0000	0.1807
T Value	8.1606	0.5195
Prob Level (T Test)	0.0000	0.6175
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0746
Regression of Y on X	0.9558	0.0002
Inverse Regression from X on Y	-0.3309	0.0067
Orthogonal Regression of Y and X	0.9558	0.0002

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.955789564946273) + (2.19911018509257E-04) * (Copper)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	1.817877E-02	1.817877E-02	0.2699	0.6175	0.0746
Error	8	0.5388408	0.0673551			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(0.0673551) = 0.2595286

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:15:01 PM

Database

Y = Asin_sqrtSurvival X = Copper

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8748	0.113815	No
Anderson Darling	0.5590	0.148758	No
D'Agostino Skewness	-1.3500	0.177025	No
D'Agostino Kurtosis	0.1917	0.847958	Yes
D'Agostino Omnibus	1.8592	0.394715	Yes
Constant Residual Variance?			
Modified Levene Test	0.5818	0.467504	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

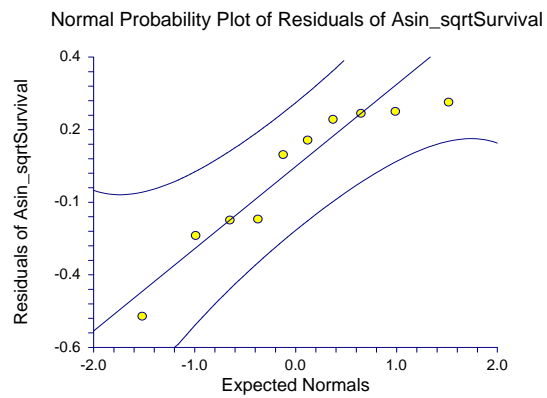
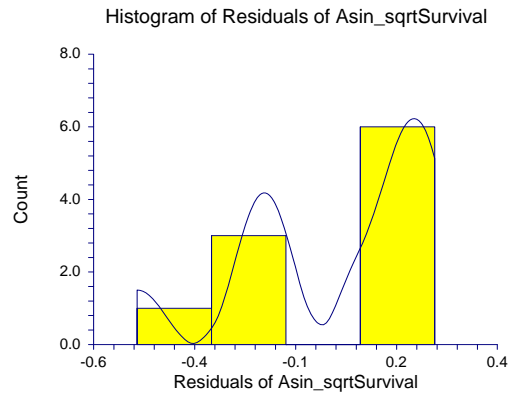
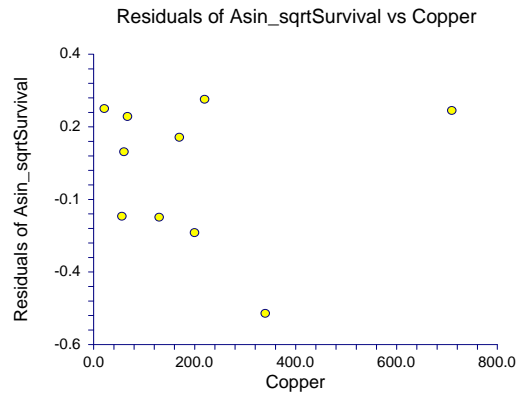
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/18/2009 1:15:01 PM
Database
Y = Asin_sqrtSurvival X = Copper

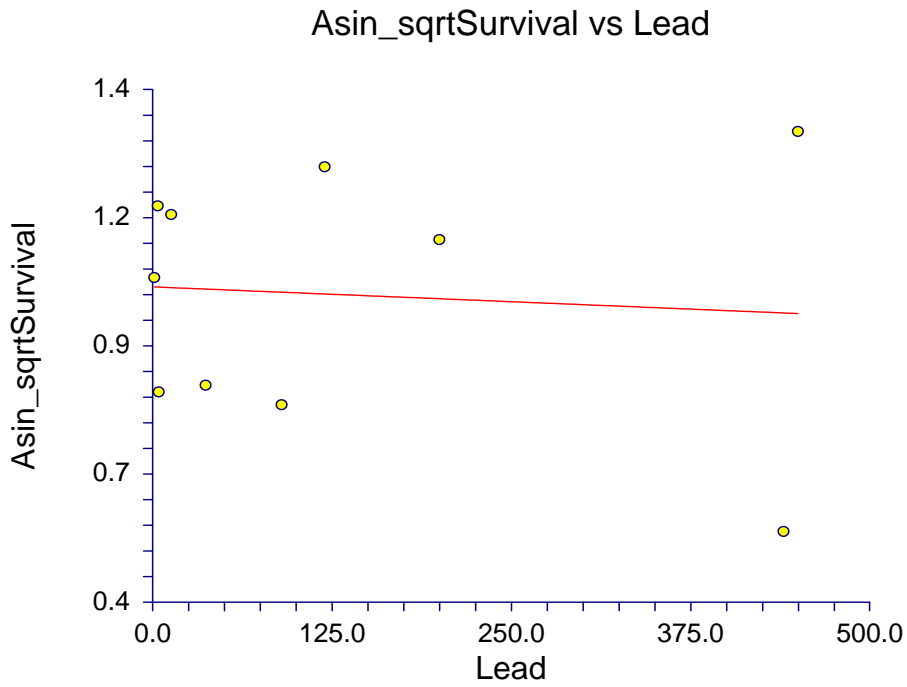
Residual Plots Section



Linear Regression Report

Page/Date/Time 1 8/18/2009 1:15:27 PM
Database
Y = Asin_sqrtSurvival X = Lead

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Lead	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.0149	Rows Prediction Only	0
Slope	-0.0001	Sum of Frequencies	10
R-Squared	0.0066	Sum of Weights	10.0000
Correlation	-0.0813	Coefficient of Variation	0.2632
Mean Square Error	6.916745E-02	Square Root of MSE	0.2629971

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:15:27 PM
Y = Asin_sqrtSurvival X = Lead

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Lead is estimated as:
 $\text{Asin_sqrtSurvival} = (1.0149) + (-0.0001) \text{Lead}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Lead is zero, is 1.0149 with a standard error of 0.1075. The slope, the estimated change in Asin_sqrtSurvival per unit change in Lead, is -0.0001 with a standard error of 0.0005. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Lead, is 0.0066. The correlation between Asin_sqrtSurvival and Lead is -0.0813.

A significance test that the slope is zero resulted in a t-value of -0.2307. The significance level of this t-test is 0.8234. Since $0.8234 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0001. The lower limit of the 95% confidence interval for the slope is -0.0013 and the upper limit is 0.0010. The estimated intercept is 1.0149. The lower limit of the 95% confidence interval for the intercept is 0.7670 and the upper limit is 1.2628.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Lead
Count	10	10
Mean	0.9992	135.9100
Standard Deviation	0.2488	174.9462
Minimum	0.5380	1.2000
Maximum	1.3180	450.0000

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:15:27 PM

Database

Y = Asin_sqrtSurvival X = Lead

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.0149	-0.0001
Lower 95% Confidence Limit	0.7670	-0.0013
Upper 95% Confidence Limit	1.2628	0.0010
Standard Error	0.1075	0.0005
Standardized Coefficient	0.0000	-0.0813
T Value	9.4415	-0.2307
Prob Level (T Test)	0.0000	0.8234
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0548
Regression of Y on X	1.0149	-0.0001
Inverse Regression from X on Y	3.3770	-0.0175
Orthogonal Regression of Y and X	1.0149	-0.0001

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.01490905049605) + (-1.15584213788872E-04) * (Lead)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	3.680007E-03	3.680007E-03	0.0532	0.8234	0.0548
Error	8	0.5533396	6.916745E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(6.916745E-02) = 0.2629971

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:15:27 PM

Database

Y = Asin_sqrtSurvival X = Lead

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9477	0.641882	Yes
Anderson Darling	0.3188	0.535310	Yes
D'Agostino Skewness	-0.4748	0.634957	Yes
D'Agostino Kurtosis	-0.6652	0.505905	Yes
D'Agostino Omnibus	0.6679	0.716080	Yes
Constant Residual Variance?			
Modified Levene Test	1.2382	0.298136	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

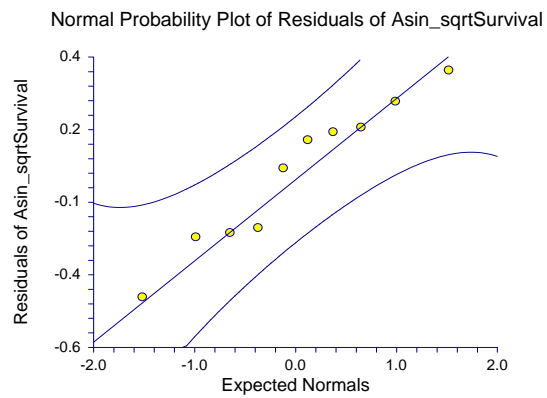
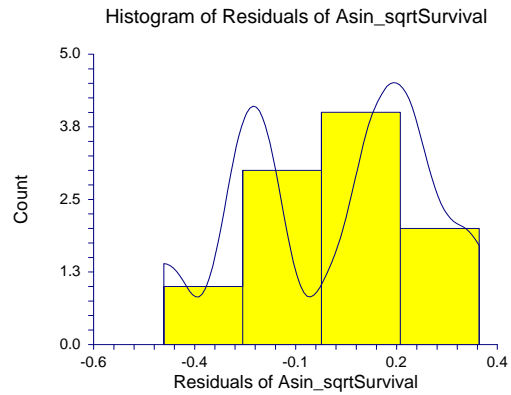
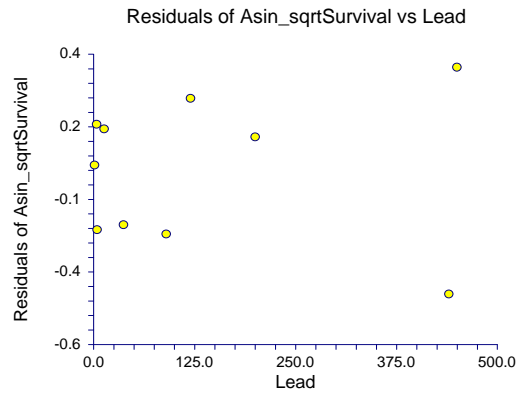
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/18/2009 1:15:27 PM
Database
Y = Asin_sqrtSurvival X = Lead

Residual Plots Section



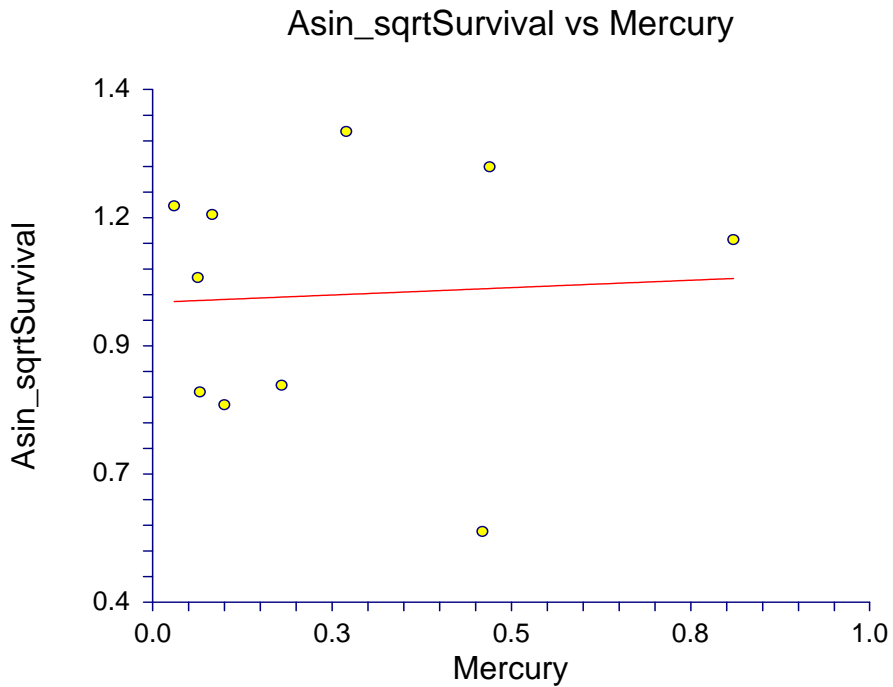
Linear Regression Report

Page/Date/Time 1 8/18/2009 1:15:38 PM

Database

Y = Asin_sqrtSurvival X = Mercury

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Mercury	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.9846	Rows Prediction Only	0
Slope	0.0577	Sum of Frequencies	10
R-Squared	0.0035	Sum of Weights	10.0000
Correlation	0.0588	Coefficient of Variation	0.2636
Mean Square Error	6.938682E-02	Square Root of MSE	0.2634138

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:15:38 PM
Y = Asin_sqrtSurvival X = Mercury

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Mercury is estimated as:
 $\text{Asin_sqrtSurvival} = (0.9846) + (0.0577) \text{ Mercury}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Mercury is zero, is 0.9846 with a standard error of 0.1209. The slope, the estimated change in Asin_sqrtSurvival per unit change in Mercury, is 0.0577 with a standard error of 0.3462. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Mercury, is 0.0035. The correlation between Asin_sqrtSurvival and Mercury is 0.0588.

A significance test that the slope is zero resulted in a t-value of 0.1666. The significance level of this t-test is 0.8718. Since $0.8718 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0577. The lower limit of the 95% confidence interval for the slope is -0.7407 and the upper limit is 0.8560. The estimated intercept is 0.9846. The lower limit of the 95% confidence interval for the intercept is 0.7057 and the upper limit is 1.2635.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Mercury
Count	10	10
Mean	0.9992	0.2532
Standard Deviation	0.2488	0.2536
Minimum	0.5380	0.0300
Maximum	1.3180	0.8100

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:15:38 PM

Database

Y = Asin_sqrtSurvival X = Mercury

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.9846	0.0577
Lower 95% Confidence Limit	0.7057	-0.7407
Upper 95% Confidence Limit	1.2635	0.8560
Standard Error	0.1209	0.3462
Standardized Coefficient	0.0000	0.0588
T Value	8.1423	0.1666
Prob Level (T Test)	0.0000	0.8718
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0525
Regression of Y on X	0.9846	0.0577
Inverse Regression from X on Y	-3.2257	16.6859
Orthogonal Regression of Y and X	0.8158	0.7245

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.984599369575597) + (5.76644171579912E-02) * (Mercury)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	1.924988E-03	1.924988E-03	0.0277	0.8718	0.0525
Error	8	0.5550946	6.938682E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

$s = \text{Square Root}(6.938682E-02) = 0.2634138$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:15:38 PM

Database

Y = Asin_sqrtSurvival X = Mercury

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9351	0.500199	Yes
Anderson Darling	0.3420	0.493022	Yes
D'Agostino Skewness	-0.9241	0.355460	Yes
D'Agostino Kurtosis	-0.1140	0.909203	Yes
D'Agostino Omnibus	0.8669	0.648277	Yes
Constant Residual Variance?			
Modified Levene Test	0.8673	0.378947	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

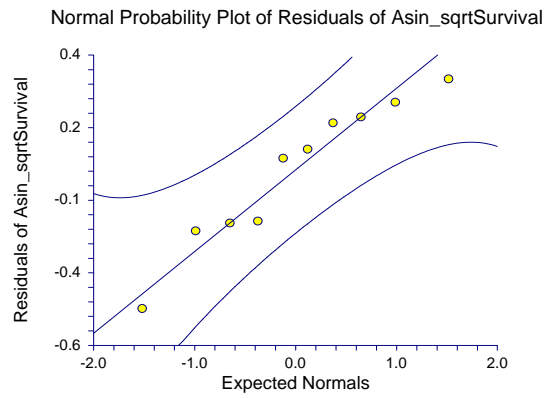
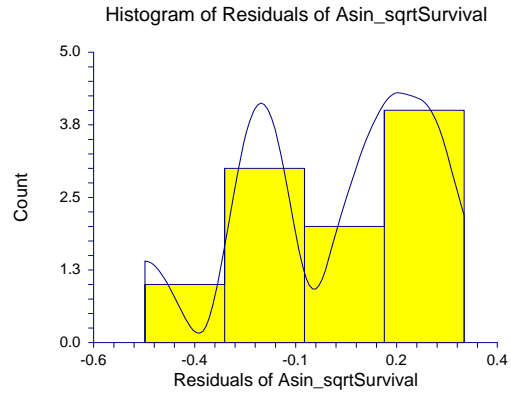
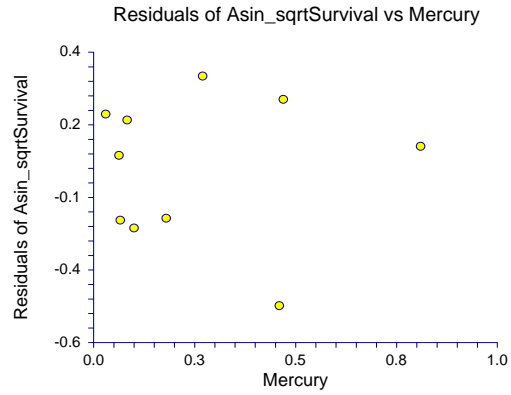
Linear Regression Report

Page/Date/Time 5 8/18/2009 1:15:38 PM

Database

Y = Asin_sqrtSurvival X = Mercury

Residual Plots Section



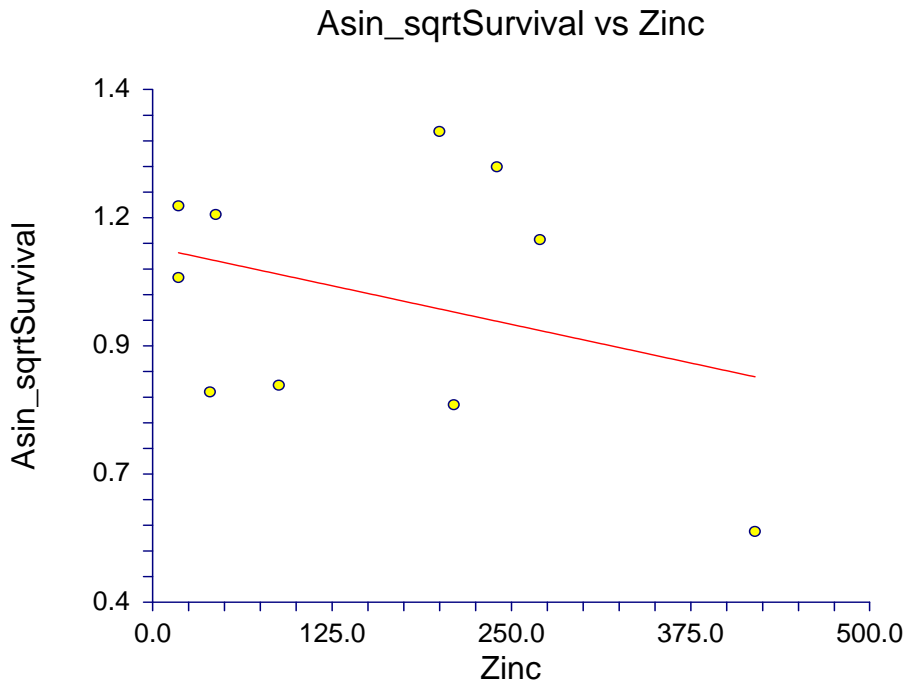
Linear Regression Report

Page/Date/Time 1 8/18/2009 1:15:53 PM

Database

Y = Asin_sqrtSurvival X = Zinc

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Zinc	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.0924	Rows Prediction Only	0
Slope	-0.0006	Sum of Frequencies	10
R-Squared	0.1062	Sum of Weights	10.0000
Correlation	-0.3260	Coefficient of Variation	0.2497
Mean Square Error	6.222992E-02	Square Root of MSE	0.2494593

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:15:53 PM

Y = Asin_sqrtSurvival X = Zinc

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Zinc is estimated as:

$\text{Asin_sqrtSurvival} = (1.0924) + (-0.0006) \text{Zinc}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Zinc is zero, is 1.0924 with a standard error of 0.1239. The slope, the estimated change in Asin_sqrtSurvival per unit change in Zinc, is -0.0006 with a standard error of 0.0006. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Zinc, is 0.1062. The correlation between Asin_sqrtSurvival and Zinc is -0.3260.

A significance test that the slope is zero resulted in a t-value of -0.9752. The significance level of this t-test is 0.3580. Since $0.3580 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0006. The lower limit of the 95% confidence interval for the slope is -0.0020 and the upper limit is 0.0008. The estimated intercept is 1.0924. The lower limit of the 95% confidence interval for the intercept is 0.8066 and the upper limit is 1.3781.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Zinc
Count	10	10
Mean	0.9992	154.8000
Standard Deviation	0.2488	134.7003
Minimum	0.5380	18.0000
Maximum	1.3180	420.0000

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:15:53 PM

Database

Y = Asin_sqrtSurvival X = Zinc

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.0924	-0.0006
Lower 95% Confidence Limit	0.8066	-0.0020
Upper 95% Confidence Limit	1.3781	0.0008
Standard Error	0.1239	0.0006
Standardized Coefficient	0.0000	-0.3260
T Value	8.8156	-0.9752
Prob Level (T Test)	0.0000	0.3580
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1386
Regression of Y on X	1.0924	-0.0006
Inverse Regression from X on Y	1.8763	-0.0057
Orthogonal Regression of Y and X	1.0924	-0.0006

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.09239002165372) + (-6.02002723861221E-04) * (Zinc)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	5.918024E-02	5.918024E-02	0.9510	0.3580	0.1386
Error	8	0.4978394	6.222992E-02			
Lack of Fit	7	0.4880394	6.971991E-02	7.1143	0.2812	
Pure Error	1	0.0098	0.0098			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(6.222992E-02) = 0.2494593

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:15:53 PM

Database

Y = Asin_sqrtSurvival X = Zinc

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9258	0.408202	Yes
Anderson Darling	0.3174	0.538392	Yes
D'Agostino Skewness	0.2406	0.809847	Yes
D'Agostino Kurtosis	-1.4024	0.160791	No
D'Agostino Omnibus	2.0247	0.363370	Yes

Constant Residual Variance?

Modified Levene Test	1.0487	0.335780	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(7, 1) Test	7.1143	0.281177	Yes
---------------------------------	--------	----------	-----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

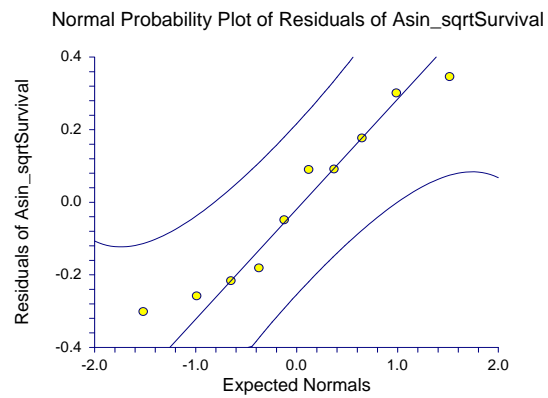
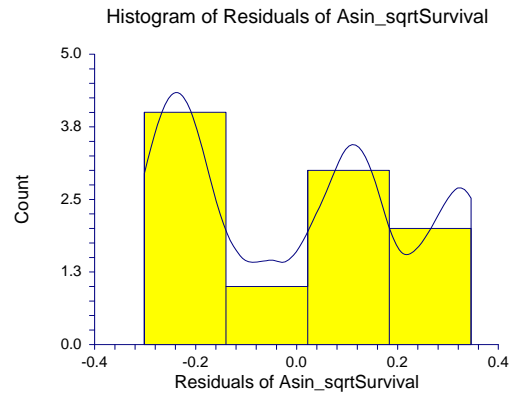
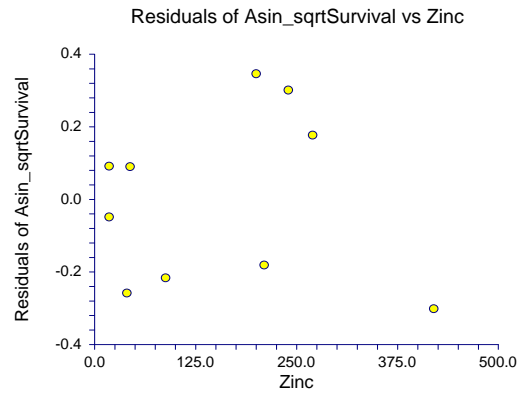
Linear Regression Report

Page/Date/Time 5 8/18/2009 1:15:53 PM

Database

Y = Asin_sqrtSurvival X = Zinc

Residual Plots Section



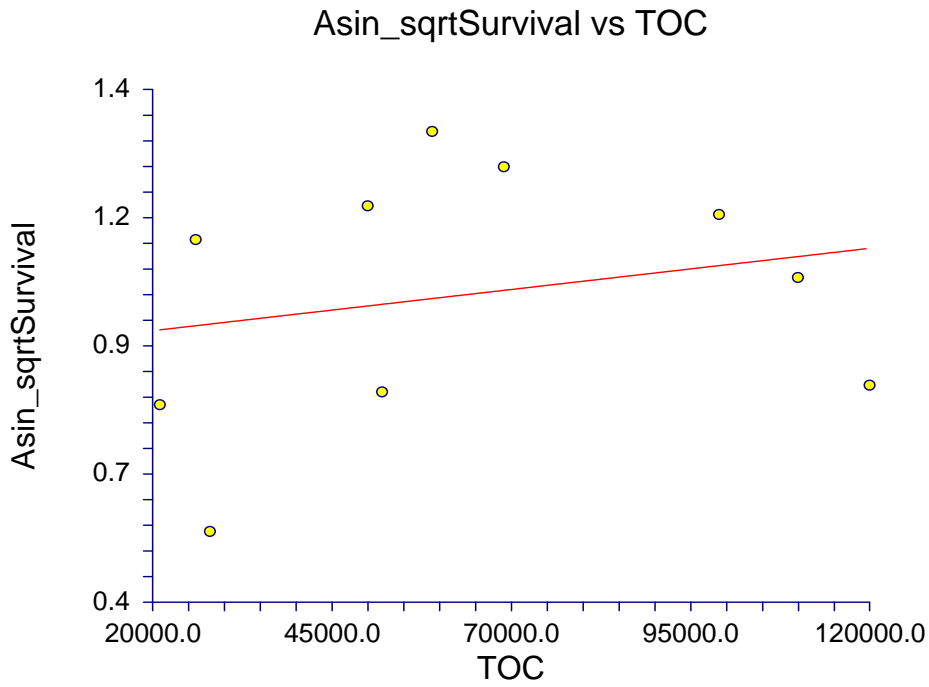
Linear Regression Report

Page/Date/Time 1 8/18/2009 1:21:39 PM

Database

Y = Asin_sqrtSurvival X = TOC

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	TOC	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.8974	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	10
R-Squared	0.0530	Sum of Weights	10.0000
Correlation	0.2302	Coefficient of Variation	0.2570
Mean Square Error	0.0659381	Square Root of MSE	0.2567841

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:21:39 PM
Y = Asin_sqrtSurvival X = TOC

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and TOC is estimated as:
 $\text{Asin_sqrtSurvival} = (0.8974) + (0.0000) \text{ TOC}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when TOC is zero, is 0.8974 with a standard error of 0.1724. The slope, the estimated change in Asin_sqrtSurvival per unit change in TOC, is 0.0000 with a standard error of 0.0000. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in TOC, is 0.0530. The correlation between Asin_sqrtSurvival and TOC is 0.2302.

A significance test that the slope is zero resulted in a t-value of 0.6690. The significance level of this t-test is 0.5223. Since $0.5223 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0000. The lower limit of the 95% confidence interval for the slope is 0.0000 and the upper limit is 0.0000. The estimated intercept is 0.8974. The lower limit of the 95% confidence interval for the intercept is 0.4998 and the upper limit is 1.2951.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	TOC
Count	10	10
Mean	0.9992	63400.0000
Standard Deviation	0.2488	35671.9622
Minimum	0.5380	21000.0000
Maximum	1.3180	120000.0000

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:21:39 PM

Database

Y = Asin_sqrtSurvival X = TOC

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.8974	0.0000
Lower 95% Confidence Limit	0.4998	0.0000
Upper 95% Confidence Limit	1.2951	0.0000
Standard Error	0.1724	0.0000
Standardized Coefficient	0.0000	0.2302
T Value	5.2041	0.6690
Prob Level (T Test)	0.0008	0.5223
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9947	0.0911
Regression of Y on X	0.8974	0.0000
Inverse Regression from X on Y	-0.9216	0.0000
Orthogonal Regression of Y and X	0.8974	0.0000

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.897420313646048) + (1.60535782892669E-06) * (TOC)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	2.951482E-02	2.951482E-02	0.4476	0.5223	0.0911
Error	8	0.5275048	0.0659381			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

$s = \text{Square Root}(0.0659381) = 0.2567841$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:21:39 PM

Database

Y = Asin_sqrtSurvival X = TOC

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9522	0.694104	Yes
Anderson Darling	0.2539	0.731782	Yes
D'Agostino Skewness	-0.4658	0.641336	Yes
D'Agostino Kurtosis	-0.9336	0.350488	Yes
D'Agostino Omnibus	1.0887	0.580222	Yes
Constant Residual Variance?			
Modified Levene Test	0.0182	0.896146	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

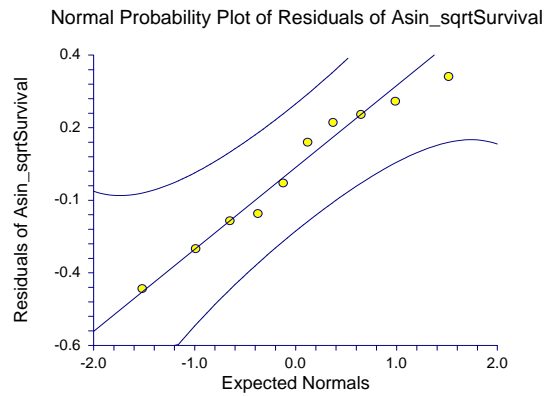
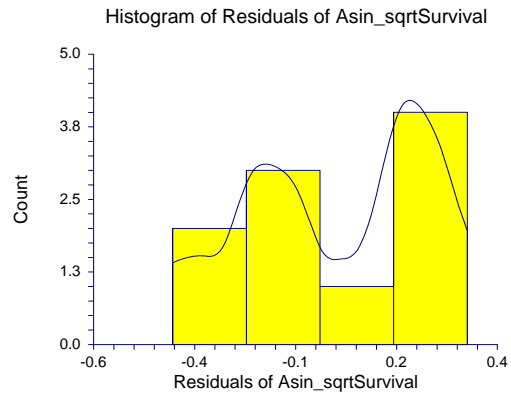
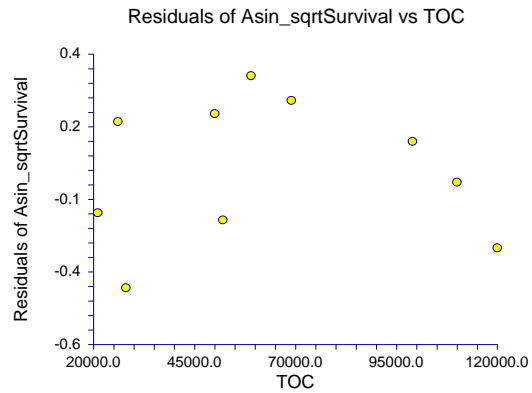
Linear Regression Report

Page/Date/Time 5 8/18/2009 1:21:39 PM

Database

Y = Asin_sqrtSurvival X = TOC

Residual Plots Section



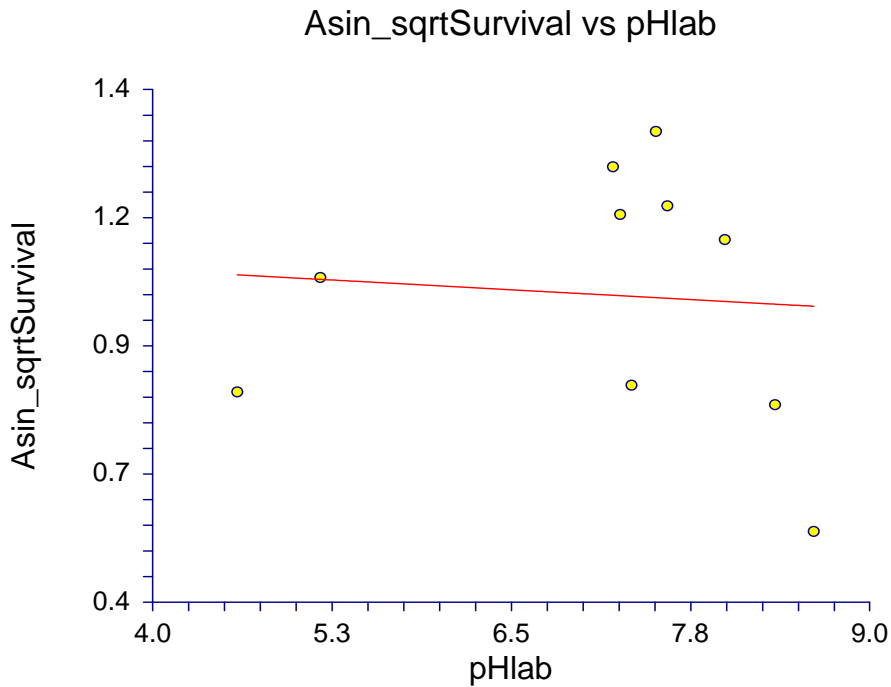
Linear Regression Report

Page/Date/Time 1 8/18/2009 1:21:20 PM

Database

Y = Asin_sqrtSurvival X = pHlab

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	pHlab	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.1084	Rows Prediction Only	0
Slope	-0.0152	Sum of Frequencies	10
R-Squared	0.0063	Sum of Weights	10.0000
Correlation	-0.0794	Coefficient of Variation	0.2632
Mean Square Error	6.918853E-02	Square Root of MSE	0.2630371

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:21:20 PM
Y = Asin_sqrtSurvival X = pHlab

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and pHlab is estimated as:
$$\text{Asin_sqrtSurvival} = (1.1084) + (-0.0152) \text{ pHlab}$$
using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when pHlab is zero, is 1.1084 with a standard error of 0.4918. The slope, the estimated change in Asin_sqrtSurvival per unit change in pHlab, is -0.0152 with a standard error of 0.0677. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in pHlab, is 0.0063. The correlation between Asin_sqrtSurvival and pHlab is -0.0794.

A significance test that the slope is zero resulted in a t-value of -0.2253. The significance level of this t-test is 0.8274. Since $0.8274 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0152. The lower limit of the 95% confidence interval for the slope is -0.1713 and the upper limit is 0.1408. The estimated intercept is 1.1084. The lower limit of the 95% confidence interval for the intercept is -0.0257 and the upper limit is 2.2425.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	pHlab
Count	10	10
Mean	0.9992	7.1610
Standard Deviation	0.2488	1.2953
Minimum	0.5380	4.5900
Maximum	1.3180	8.6100

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:21:20 PM

Database

Y = Asin_sqrtSurvival X = pHlab

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.1084	-0.0152
Lower 95% Confidence Limit	-0.0257	-0.1713
Upper 95% Confidence Limit	2.2425	0.1408
Standard Error	0.4918	0.0677
Standardized Coefficient	0.0000	-0.0794
T Value	2.2538	-0.2253
Prob Level (T Test)	0.0542	0.8274
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.5086	0.0546
Regression of Y on X	1.1084	-0.0152
Inverse Regression from X on Y	18.3214	-2.4190
Orthogonal Regression of Y and X	1.1125	-0.0158

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.10839594492848) + (-.015248700590487) * (pHlab)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	3.511349E-03	3.511349E-03	0.0508	0.8274	0.0546
Error	8	0.5535082	6.918853E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(6.918853E-02) = 0.2630371

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:21:20 PM

Database

Y = Asin_sqrtSurvival X = pHlab

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9407	0.560702	Yes
Anderson Darling	0.3205	0.531730	Yes
D'Agostino Skewness	-0.6563	0.511627	Yes
D'Agostino Kurtosis	-0.6675	0.504472	Yes
D'Agostino Omnibus	0.8763	0.645243	Yes
Constant Residual Variance?			
Modified Levene Test	0.3651	0.562423	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

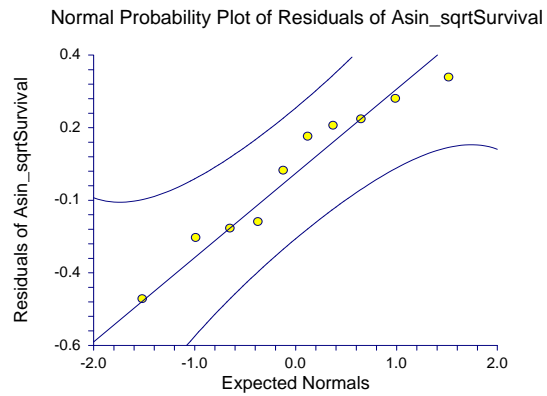
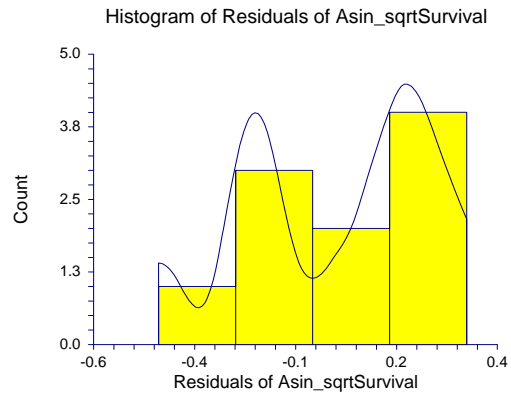
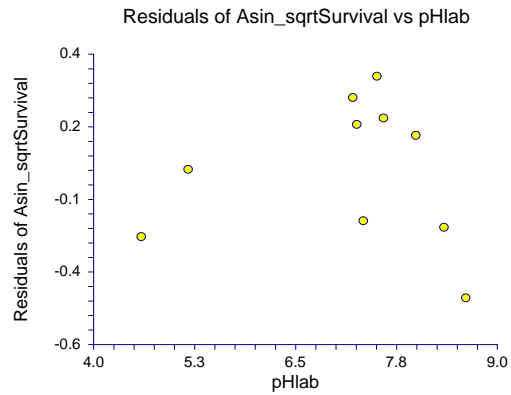
Linear Regression Report

Page/Date/Time 5 8/18/2009 1:21:20 PM

Database

Y = Asin_sqrtSurvival X = pHlab

Residual Plots Section



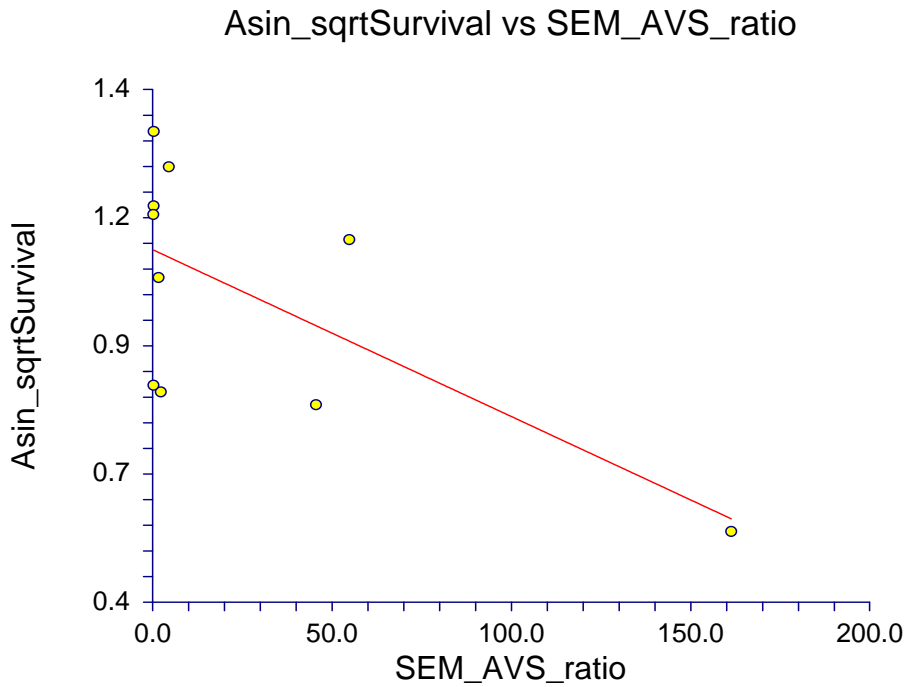
Linear Regression Report

Page/Date/Time 1 9/21/2009 10:32:54 AM

Database

Y = Asin_sqrtSurvival X = SEM_AVS_ratio

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	SEM_AVS_ratio	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.0874	Rows Prediction Only	0
Slope	-0.0033	Sum of Frequencies	10
R-Squared	0.4518	Sum of Weights	10.0000
Correlation	-0.6721	Coefficient of Variation	0.1955
Mean Square Error	3.817157E-02	Square Root of MSE	0.1953755

Linear Regression Report

Page/Date/Time 2 9/21/2009 10:32:54 AM
Y = Asin_sqrtSurvival X = SEM_AVS_ratio

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and SEM_AVS_ratio is estimated as:
 $\text{Asin_sqrtSurvival} = (1.0874) + (-0.0033) \text{ SEM_AVS_ratio}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when SEM_AVS_ratio is zero, is 1.0874 with a standard error of 0.0707. The slope, the estimated change in Asin_sqrtSurvival per unit change in SEM_AVS_ratio, is -0.0033 with a standard error of 0.0013. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in SEM_AVS_ratio, is 0.4518. The correlation between Asin_sqrtSurvival and SEM_AVS_ratio is -0.6721.

A significance test that the slope is zero resulted in a t-value of -2.5676. The significance level of this t-test is 0.0333. Since $0.0333 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is -0.0033. The lower limit of the 95% confidence interval for the slope is -0.0062 and the upper limit is -0.0003. The estimated intercept is 1.0874. The lower limit of the 95% confidence interval for the intercept is 0.9244 and the upper limit is 1.2504.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	SEM_AVS_ratio
Count	10	10
Mean	0.9992	27.1279
Standard Deviation	0.2488	51.4284
Minimum	0.5380	0.1901
Maximum	1.3180	161.3828

Linear Regression Report

Page/Date/Time 3 9/21/2009 10:32:54 AM

Database

Y = Asin_sqrtSurvival X = SEM_AVS_ratio

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.0874	-0.0033
Lower 95% Confidence Limit	0.9244	-0.0062
Upper 95% Confidence Limit	1.2504	-0.0003
Standard Error	0.0707	0.0013
Standardized Coefficient	0.0000	-0.6721
T Value	15.3824	-2.5676
Prob Level (T Test)	0.0000	0.0333
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	1.0000	0.6157
Regression of Y on X	1.0874	-0.0033
Inverse Regression from X on Y	1.1944	-0.0072
Orthogonal Regression of Y and X	1.0874	-0.0033

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(1.08740375774294) + (-3.25140741764619E-03) * (SEM_AVS_ratio)$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	0.2516471	0.2516471	6.5925	0.0333	0.6157
Error	8	0.3053726	3.817157E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

$s = \text{Square Root}(3.817157E-02) = 0.1953755$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/21/2009 10:32:54 AM

Database

Y = Asin_sqrtSurvival X = SEM_AVS_ratio

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9229	0.381355	Yes
Anderson Darling	0.2994	0.584299	Yes
D'Agostino Skewness	-0.5074	0.611856	Yes
D'Agostino Kurtosis	-1.0811	0.279632	Yes
D'Agostino Omnibus	1.4264	0.490084	Yes
Constant Residual Variance?			
Modified Levene Test	0.2021	0.664936	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

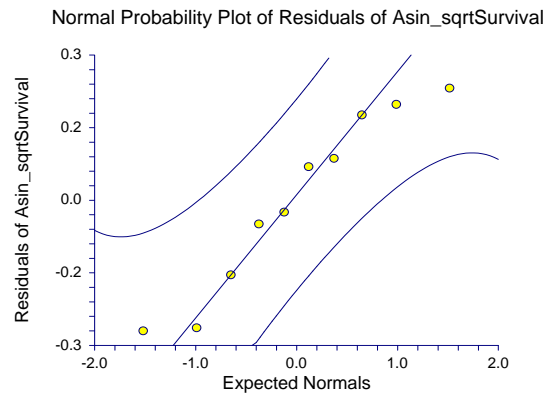
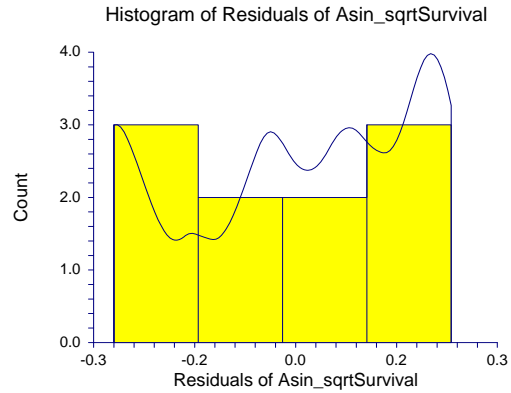
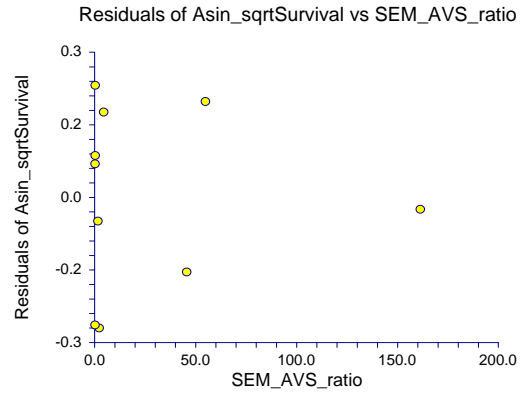
Linear Regression Report

Page/Date/Time 5 9/21/2009 10:32:54 AM

Database

Y = Asin_sqrtSurvival X = SEM_AVS_ratio

Residual Plots Section



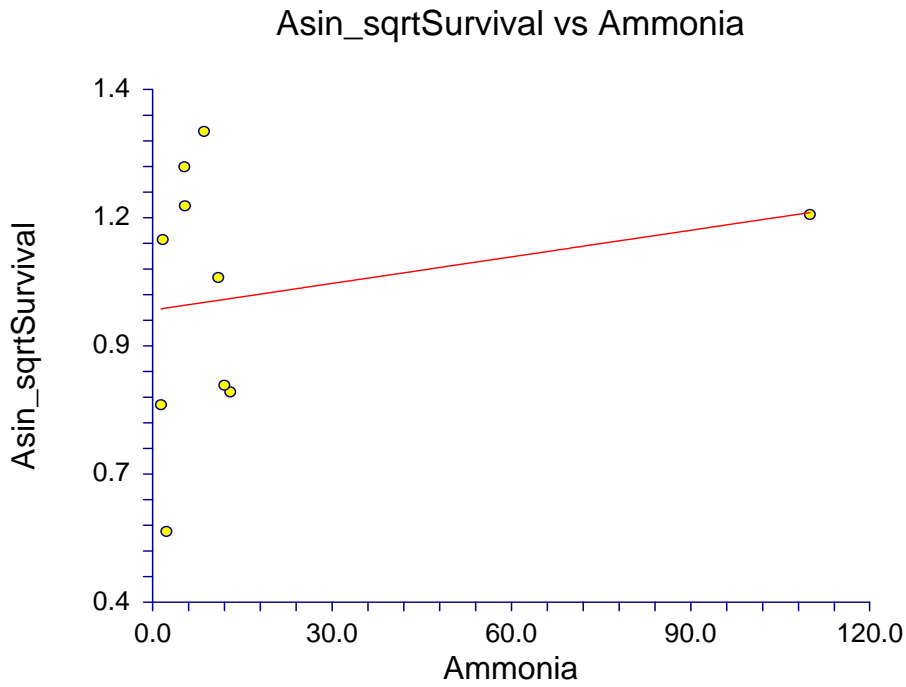
Linear Regression Report

Page/Date/Time 1 8/18/2009 1:16:30 PM

Database

Y = Asin_sqrtSurvival X = Ammonia

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Ammonia	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.9697	Rows Prediction Only	0
Slope	0.0017	Sum of Frequencies	10
R-Squared	0.0524	Sum of Weights	10.0000
Correlation	0.2288	Coefficient of Variation	0.2571
Mean Square Error	6.598196E-02	Square Root of MSE	0.2568696

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:16:30 PM
Y = Asin_sqrtSurvival X = Ammonia

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Ammonia is estimated as:
 $\text{Asin_sqrtSurvival} = (0.9697) + (0.0017) \text{ Ammonia}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Ammonia is zero, is 0.9697 with a standard error of 0.0926. The slope, the estimated change in Asin_sqrtSurvival per unit change in Ammonia, is 0.0017 with a standard error of 0.0026. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Ammonia, is 0.0524. The correlation between Asin_sqrtSurvival and Ammonia is 0.2288.

A significance test that the slope is zero resulted in a t-value of 0.6648. The significance level of this t-test is 0.5249. Since $0.5249 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0017. The lower limit of the 95% confidence interval for the slope is -0.0043 and the upper limit is 0.0077. The estimated intercept is 0.9697. The lower limit of the 95% confidence interval for the intercept is 0.7562 and the upper limit is 1.1831.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Ammonia
Count	10	10
Mean	0.9992	17.0700
Standard Deviation	0.2488	32.9334
Minimum	0.5380	1.4000
Maximum	1.3180	110.0000

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:16:30 PM

Database

Y = Asin_sqrtSurvival X = Ammonia

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.9697	0.0017
Lower 95% Confidence Limit	0.7562	-0.0043
Upper 95% Confidence Limit	1.1831	0.0077
Standard Error	0.0926	0.0026
Standardized Coefficient	0.0000	0.2288
T Value	10.4761	0.6648
Prob Level (T Test)	0.0000	0.5249
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.0905
Regression of Y on X	0.9697	0.0017
Inverse Regression from X on Y	0.4357	0.0330
Orthogonal Regression of Y and X	0.9697	0.0017

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.969694845085812) + (1.72848007698816E-03) * (Ammonia)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	2.916388E-02	2.916388E-02	0.4420	0.5249	0.0905
Error	8	0.5278557	6.598196E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(6.598196E-02) = 0.2568696

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:16:30 PM

Database

Y = Asin_sqrtSurvival X = Ammonia

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9585	0.768183	Yes
Anderson Darling	0.2320	0.801075	Yes
D'Agostino Skewness	-0.4913	0.623210	Yes
D'Agostino Kurtosis	-0.3516	0.725148	Yes
D'Agostino Omnibus	0.3650	0.833187	Yes
Constant Residual Variance?			
Modified Levene Test	0.3657	0.562123	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

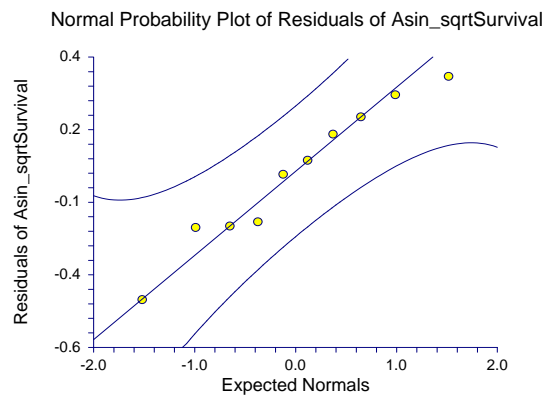
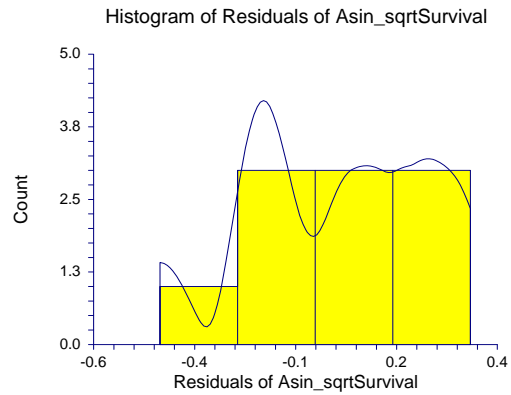
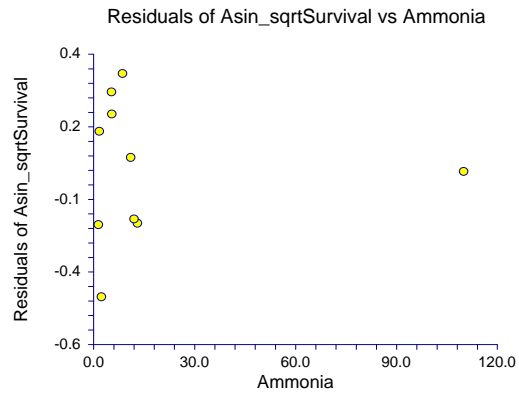
Linear Regression Report

Page/Date/Time 5 8/18/2009 1:16:30 PM

Database

Y = Asin_sqrtSurvival X = Ammonia

Residual Plots Section



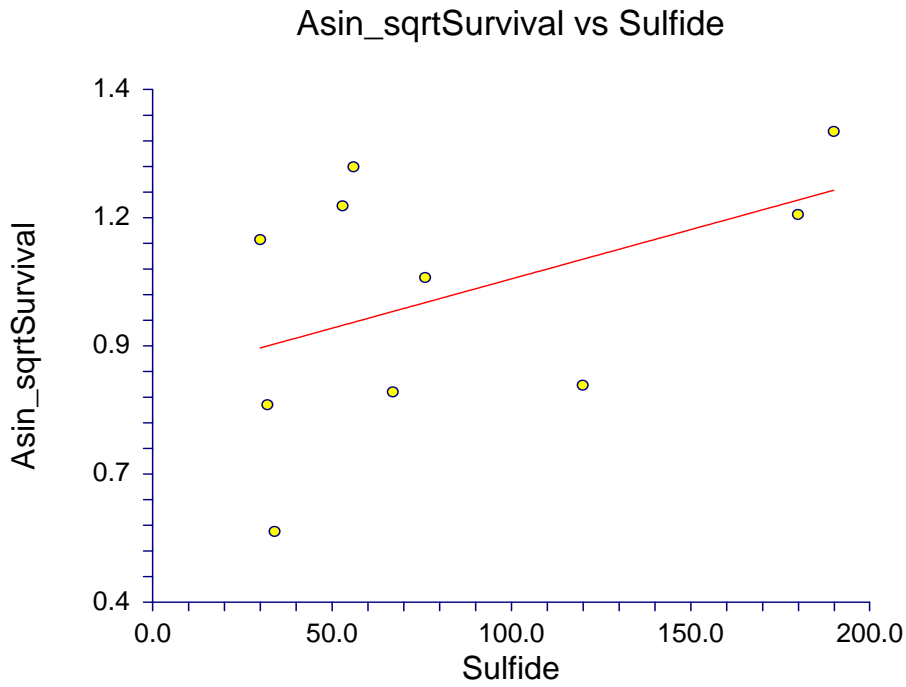
Linear Regression Report

Page/Date/Time 1 8/18/2009 1:16:49 PM

Database

Y = Asin_sqrtSurvival X = Sulfide

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Sulfide	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.8381	Rows Prediction Only	0
Slope	0.0019	Sum of Frequencies	10
R-Squared	0.2120	Sum of Weights	10.0000
Correlation	0.4605	Coefficient of Variation	0.2344
Mean Square Error	5.486435E-02	Square Root of MSE	0.2342314

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:16:49 PM
Y = Asin_sqrtSurvival X = Sulfide

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Sulfide is estimated as:
 $\text{Asin_sqrtSurvival} = (0.8381) + (0.0019) \text{ Sulfide}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Sulfide is zero, is 0.8381 with a standard error of 0.1324. The slope, the estimated change in Asin_sqrtSurvival per unit change in Sulfide, is 0.0019 with a standard error of 0.0013. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Sulfide, is 0.2120. The correlation between Asin_sqrtSurvival and Sulfide is 0.4605.

A significance test that the slope is zero resulted in a t-value of 1.4672. The significance level of this t-test is 0.1805. Since $0.1805 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0019. The lower limit of the 95% confidence interval for the slope is -0.0011 and the upper limit is 0.0049. The estimated intercept is 0.8381. The lower limit of the 95% confidence interval for the intercept is 0.5327 and the upper limit is 1.1435.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Sulfide
Count	10	10
Mean	0.9992	83.8000
Standard Deviation	0.2488	59.5964
Minimum	0.5380	30.0000
Maximum	1.3180	190.0000

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:16:49 PM

Database

Y = Asin_sqrtSurvival X = Sulfide

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.8381	0.0019
Lower 95% Confidence Limit	0.5327	-0.0011
Upper 95% Confidence Limit	1.1435	0.0049
Standard Error	0.1324	0.0013
Standardized Coefficient	0.0000	0.4605
T Value	6.3285	1.4672
Prob Level (T Test)	0.0002	0.1805
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9998	0.2535
Regression of Y on X	0.8381	0.0019
Inverse Regression from X on Y	0.2395	0.0091
Orthogonal Regression of Y and X	0.8381	0.0019

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.838121937332633) + (1.92217258552944E-03) * (Sulfide)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	0.1181048	0.1181048	2.1527	0.1805	0.2535
Error	8	0.4389148	5.486435E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

$s = \text{Square Root}(5.486435E-02) = 0.2342314$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:16:49 PM

Database

Y = Asin_sqrtSurvival X = Sulfide

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9665	0.856209	Yes
Anderson Darling	0.1704	0.932650	Yes
D'Agostino Skewness	-0.3397	0.734070	Yes
D'Agostino Kurtosis	-0.8089	0.418551	Yes
D'Agostino Omnibus	0.7698	0.680523	Yes
Constant Residual Variance?			
Modified Levene Test	0.6067	0.458456	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

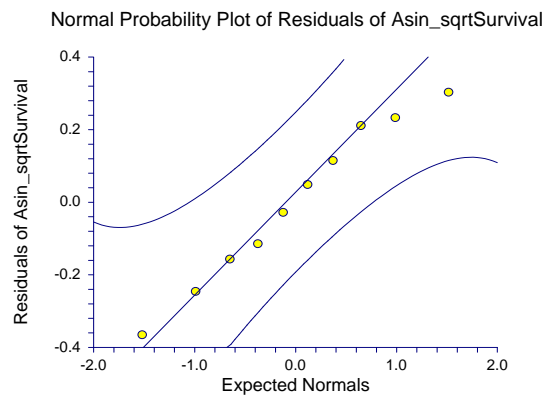
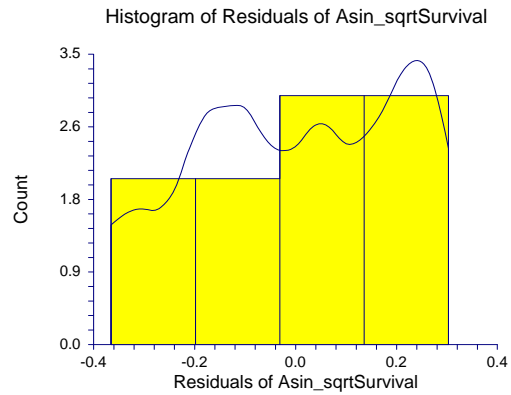
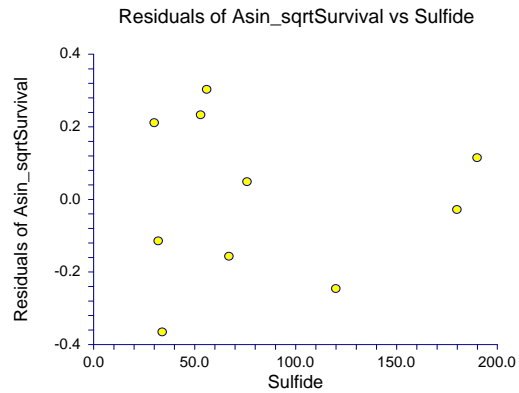
Linear Regression Report

Page/Date/Time 5 8/18/2009 1:16:49 PM

Database

Y = Asin_sqrtSurvival X = Sulfide

Residual Plots Section



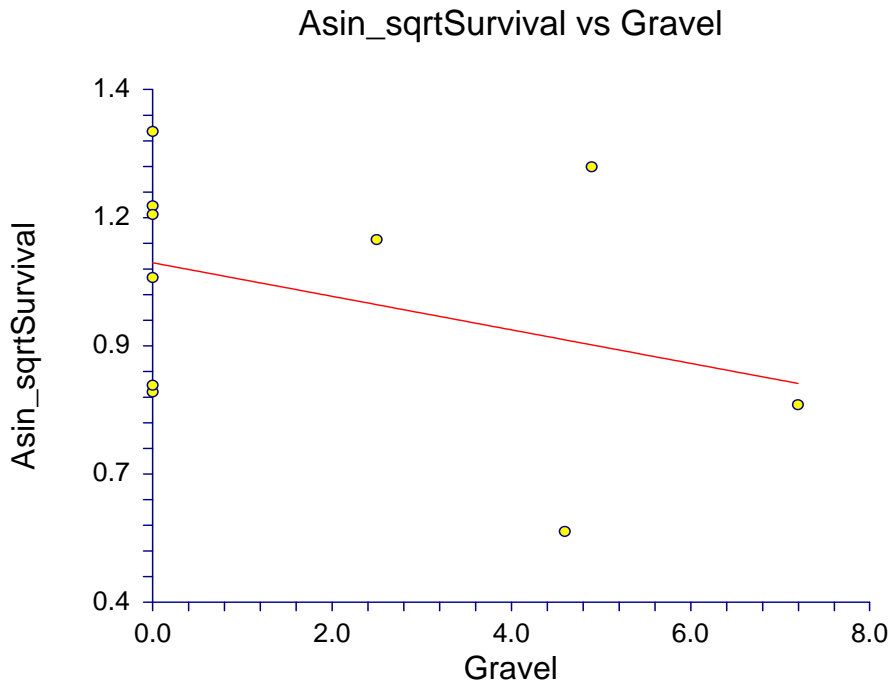
Linear Regression Report

Page/Date/Time 1 8/18/2009 1:21:58 PM

Database

Y = Asin_sqrtSurvival X = Gravel

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Gravel	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.0620	Rows Prediction Only	0
Slope	-0.0327	Sum of Frequencies	10
R-Squared	0.1274	Sum of Weights	10.0000
Correlation	-0.3569	Coefficient of Variation	0.2467
Mean Square Error	6.076031E-02	Square Root of MSE	0.2464961

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:21:58 PM
Y = Asin_sqrtSurvival X = Gravel

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Gravel is estimated as:
 $\text{Asin_sqrtSurvival} = (1.0620) + (-0.0327) \text{ Gravel}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Gravel is zero, is 1.0620 with a standard error of 0.0972. The slope, the estimated change in Asin_sqrtSurvival per unit change in Gravel, is -0.0327 with a standard error of 0.0303. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Gravel, is 0.1274. The correlation between Asin_sqrtSurvival and Gravel is -0.3569.

A significance test that the slope is zero resulted in a t-value of -1.0805. The significance level of this t-test is 0.3114. Since $0.3114 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0327. The lower limit of the 95% confidence interval for the slope is -0.1024 and the upper limit is 0.0371. The estimated intercept is 1.0620. The lower limit of the 95% confidence interval for the intercept is 0.8378 and the upper limit is 1.2861.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Gravel
Count	10	10
Mean	0.9992	1.9200
Standard Deviation	0.2488	2.7161
Minimum	0.5380	0.0000
Maximum	1.3180	7.2000

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:21:58 PM

Database

Y = Asin_sqrtSurvival X = Gravel

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.0620	-0.0327
Lower 95% Confidence Limit	0.8378	-0.1024
Upper 95% Confidence Limit	1.2861	0.0371
Standard Error	0.0972	0.0303
Standardized Coefficient	0.0000	-0.3569
T Value	10.9245	-1.0805
Prob Level (T Test)	0.0000	0.3114
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1593
Regression of Y on X	1.0620	-0.0327
Inverse Regression from X on Y	1.4920	-0.2567
Orthogonal Regression of Y and X	1.0624	-0.0329

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.06195770829568) + (-3.26863064040002E-02) * (Gravel)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	7.093713E-02	7.093713E-02	1.1675	0.3114	0.1593
Error	8	0.4860825	6.076031E-02			
Lack of Fit	3	0.2785036	9.283455E-02	2.2361	0.2020	
Pure Error	5	0.2075788	4.151577E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(6.076031E-02) = 0.2464961

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:21:58 PM

Database

Y = Asin_sqrtSurvival X = Gravel

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9589	0.773326	Yes
Anderson Darling	0.2442	0.763371	Yes
D'Agostino Skewness	-0.3170	0.751251	Yes
D'Agostino Kurtosis	-0.6288	0.529490	Yes
D'Agostino Omnibus	0.4959	0.780418	Yes
Constant Residual Variance?			
Modified Levene Test	0.4944	0.501896	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(3, 5) Test	2.2361	0.201975	Yes

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

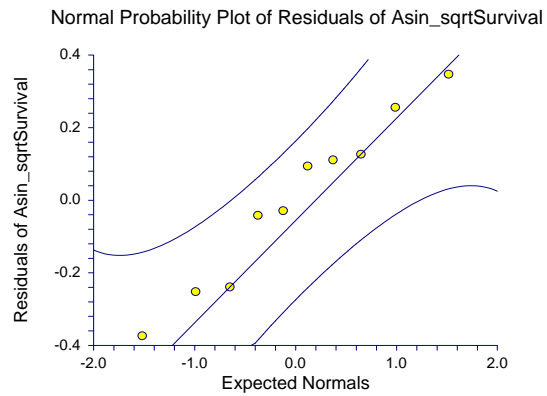
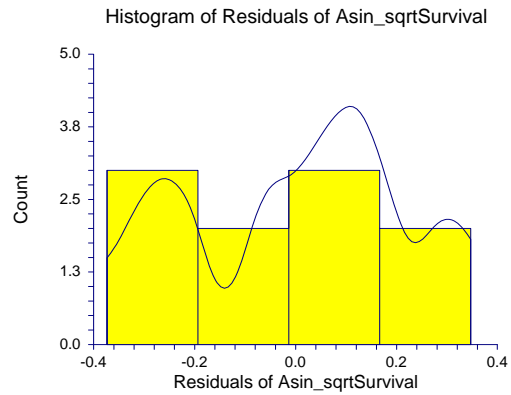
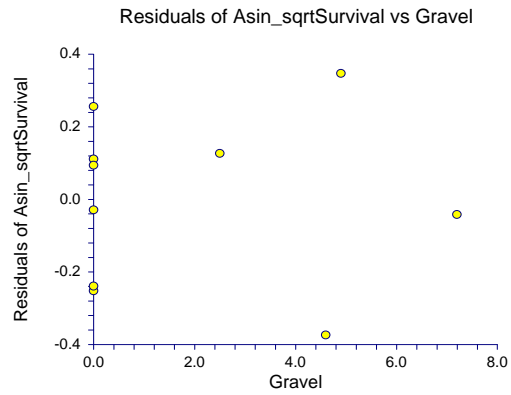
Linear Regression Report

Page/Date/Time 5 8/18/2009 1:21:58 PM

Database

Y = Asin_sqrtSurvival X = Gravel

Residual Plots Section



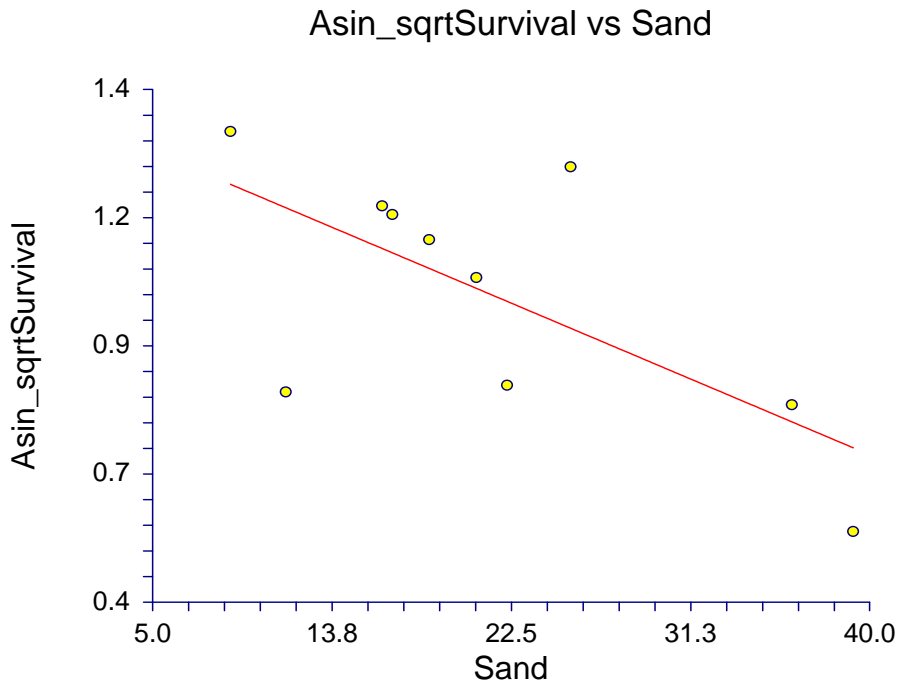
Linear Regression Report

Page/Date/Time 1 8/18/2009 1:22:19 PM

Database

Y = Asin_sqrtSurvival X = Sand

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Sand	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.3636	Rows Prediction Only	0
Slope	-0.0169	Sum of Frequencies	10
R-Squared	0.4447	Sum of Weights	10.0000
Correlation	-0.6669	Coefficient of Variation	0.1968
Mean Square Error	3.866119E-02	Square Root of MSE	0.1966245

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:22:19 PM
Y = Asin_sqrtSurvival X = Sand

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Sand is estimated as:
 $\text{Asin_sqrtSurvival} = (1.3636) + (-0.0169) \text{ Sand}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Sand is zero, is 1.3636 with a standard error of 0.1568. The slope, the estimated change in Asin_sqrtSurvival per unit change in Sand, is -0.0169 with a standard error of 0.0067. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Sand, is 0.4447. The correlation between Asin_sqrtSurvival and Sand is -0.6669.

A significance test that the slope is zero resulted in a t-value of -2.5313. The significance level of this t-test is 0.0352. Since $0.0352 < 0.0500$, the hypothesis that the slope is zero is rejected.

The estimated slope is -0.0169. The lower limit of the 95% confidence interval for the slope is -0.0323 and the upper limit is -0.0015. The estimated intercept is 1.3636. The lower limit of the 95% confidence interval for the intercept is 1.0020 and the upper limit is 1.7252.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Sand
Count	10	10
Mean	0.9992	21.5600
Standard Deviation	0.2488	9.8155
Minimum	0.5380	8.8000
Maximum	1.3180	39.2000

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:22:19 PM

Database

Y = Asin_sqrtSurvival X = Sand

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.3636	-0.0169
Lower 95% Confidence Limit	1.0020	-0.0323
Upper 95% Confidence Limit	1.7252	-0.0015
Standard Error	0.1568	0.0067
Standardized Coefficient	0.0000	-0.6669
T Value	8.6956	-2.5313
Prob Level (T Test)	0.0000	0.0352
Reject H0 (Alpha = 0.0500)	Yes	Yes
Power (Alpha = 0.0500)	1.0000	0.6036
Regression of Y on X	1.3636	-0.0169
Inverse Regression from X on Y	1.8186	-0.0380
Orthogonal Regression of Y and X	1.3638	-0.0169

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.36362025316456) + (-1.69026091449239E-02) * (Sand)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	0.24773	0.24773	6.4077	0.0352	0.6036
Error	8	0.3092895	3.866119E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(3.866119E-02) = 0.1966245

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:22:19 PM

Database

Y = Asin_sqrtSurvival X = Sand

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9244	0.395555	Yes
Anderson Darling	0.5058	0.201956	Yes
D'Agostino Skewness	-0.7066	0.479827	Yes
D'Agostino Kurtosis	0.8004	0.423503	Yes
D'Agostino Omnibus	1.1398	0.565574	Yes
Constant Residual Variance?			
Modified Levene Test	0.1339	0.723903	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

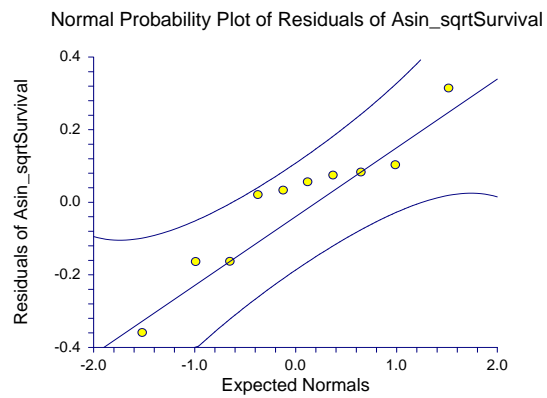
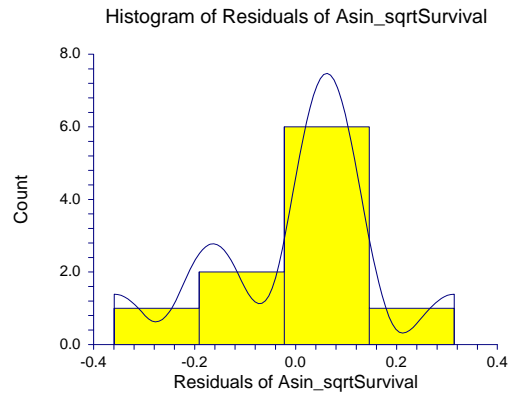
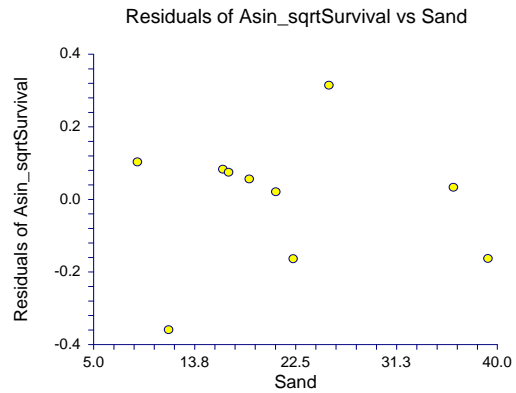
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/18/2009 1:22:19 PM
Database
Y = Asin_sqrtSurvival X = Sand

Residual Plots Section



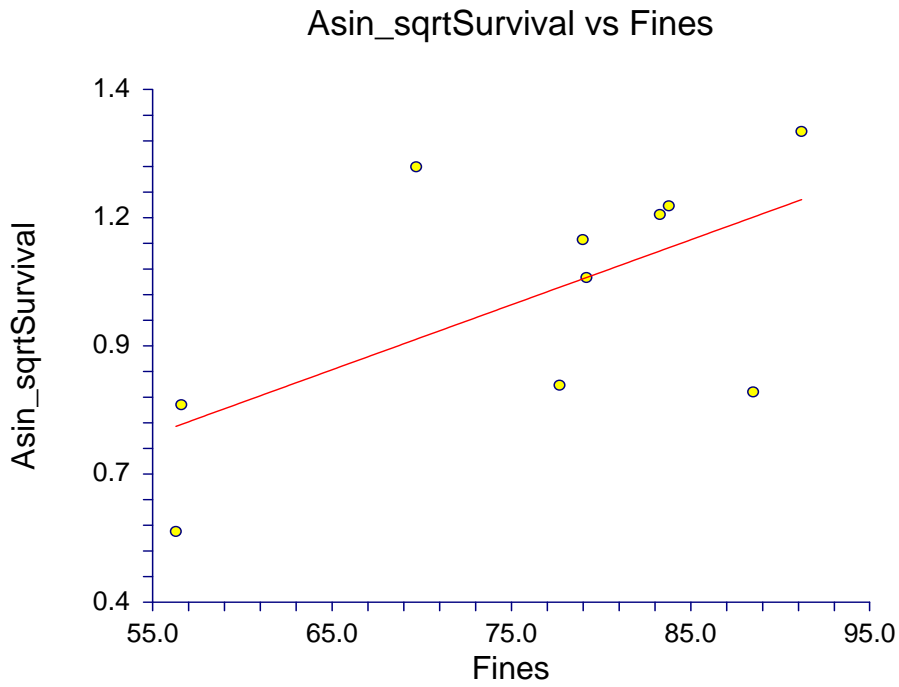
Linear Regression Report

Page/Date/Time 1 8/18/2009 1:22:35 PM

Database

Y = Asin_sqrtSurvival X = Fines

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	Fines	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0299	Rows Prediction Only	0
Slope	0.0127	Sum of Frequencies	10
R-Squared	0.3816	Sum of Weights	10.0000
Correlation	0.6177	Coefficient of Variation	0.2077
Mean Square Error	4.306062E-02	Square Root of MSE	0.2075105

Linear Regression Report

Page/Date/Time 2 8/18/2009 1:22:35 PM
Y = Asin_sqrtSurvival X = Fines

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and Fines is estimated as:
$$\text{Asin_sqrtSurvival} = (0.0299) + (0.0127) \text{ Fines}$$
using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when Fines is zero, is 0.0299 with a standard error of 0.4412. The slope, the estimated change in Asin_sqrtSurvival per unit change in Fines, is 0.0127 with a standard error of 0.0057. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in Fines, is 0.3816. The correlation between Asin_sqrtSurvival and Fines is 0.6177.

A significance test that the slope is zero resulted in a t-value of 2.2216. The significance level of this t-test is 0.0570. Since $0.0570 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0127. The lower limit of the 95% confidence interval for the slope is -0.0005 and the upper limit is 0.0258. The estimated intercept is 0.0299. The lower limit of the 95% confidence interval for the intercept is -0.9875 and the upper limit is 1.0473.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	Fines
Count	10	10
Mean	0.9992	76.5300
Standard Deviation	0.2488	12.1330
Minimum	0.5380	56.3000
Maximum	1.3180	91.2000

Linear Regression Report

Page/Date/Time 3 8/18/2009 1:22:35 PM

Database

Y = Asin_sqrtSurvival X = Fines

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.0299	0.0127
Lower 95% Confidence Limit	-0.9875	-0.0005
Upper 95% Confidence Limit	1.0473	0.0258
Standard Error	0.4412	0.0057
Standardized Coefficient	0.0000	0.6177
T Value	0.0678	2.2216
Prob Level (T Test)	0.9476	0.0570
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.0504	0.4975
Regression of Y on X	0.0299	0.0127
Inverse Regression from X on Y	-1.5412	0.0332
Orthogonal Regression of Y and X	0.0296	0.0127

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(2.99000604582569E-02) + (1.26656205349763E-02) * (\text{Fines})$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	0.2125347	0.2125347	4.9357	0.0570	0.4975
Error	8	0.3444849	4.306062E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

$s = \text{Square Root}(4.306062E-02) = 0.2075105$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 8/18/2009 1:22:35 PM

Database

Y = Asin_sqrtSurvival X = Fines

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9393	0.544917	Yes
Anderson Darling	0.4233	0.319589	Yes
D'Agostino Skewness	-0.3736	0.708688	Yes
D'Agostino Kurtosis	0.2783	0.780790	Yes
D'Agostino Omnibus	0.2170	0.897163	Yes
Constant Residual Variance?			
Modified Levene Test	0.2728	0.615582	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

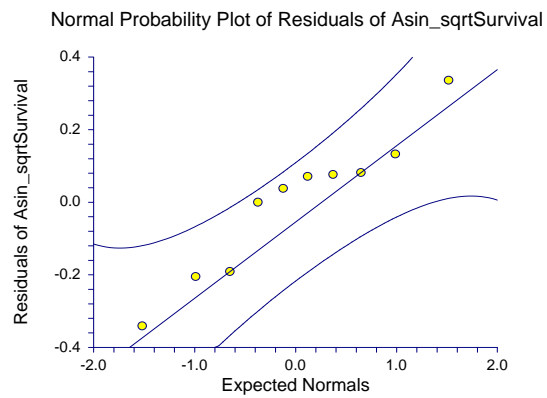
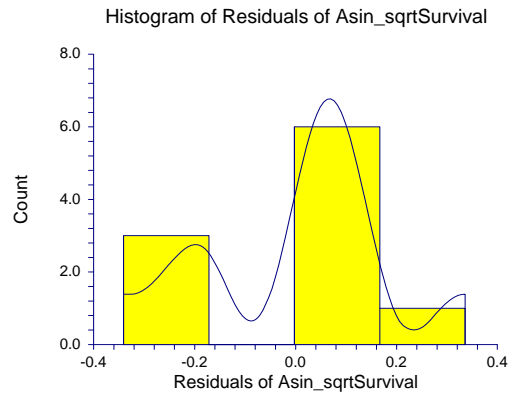
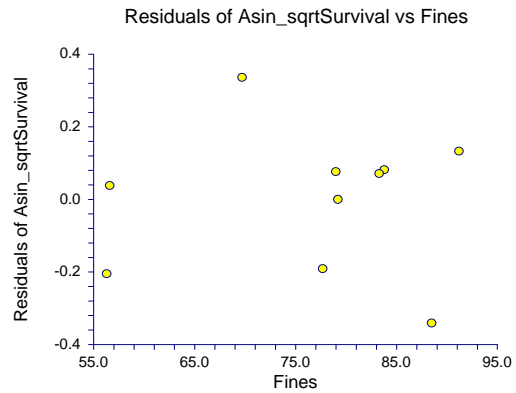
Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

Page/Date/Time 5 8/18/2009 1:22:35 PM
Database
Y = Asin_sqrtSurvival X = Fines

Residual Plots Section



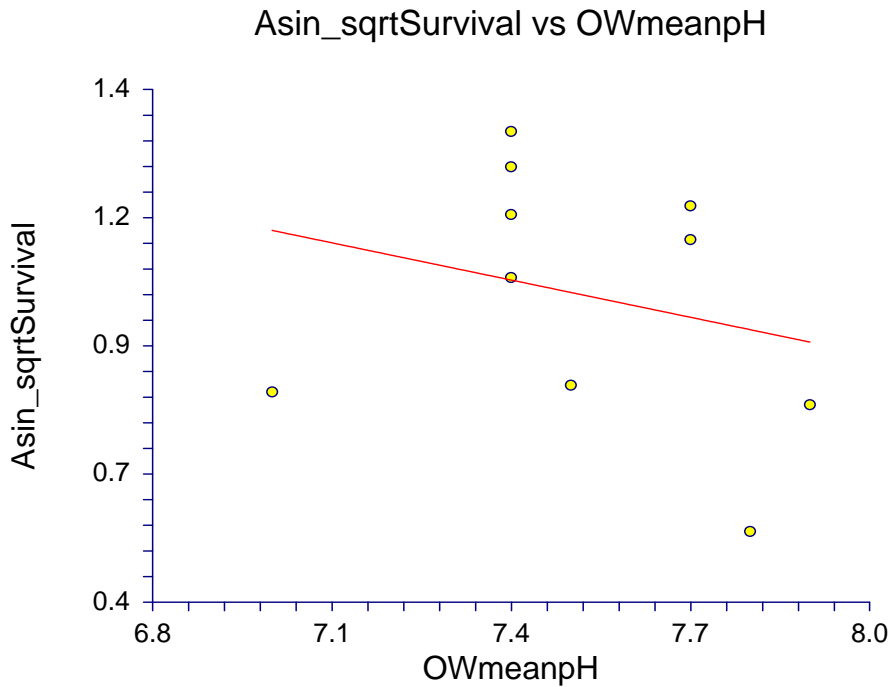
Linear Regression Report

Page/Date/Time 1 9/21/2009 10:36:53 AM

Database

Y = Asin_sqrtSurvival X = OWmeanpH

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	OWmeanpH	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	2.8186	Rows Prediction Only	0
Slope	-0.2419	Sum of Frequencies	10
R-Squared	0.0647	Sum of Weights	10.0000
Correlation	-0.2544	Coefficient of Variation	0.2554
Mean Square Error	6.511996E-02	Square Root of MSE	0.2551861

Linear Regression Report

Page/Date/Time 2 9/21/2009 10:36:53 AM
Y = Asin_sqrtSurvival X = OWmeanpH

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and OWmeanpH is estimated as:
 $\text{Asin_sqrtSurvival} = (2.8186) + (-0.2419) \text{OWmeanpH}$ using the 10 observations in this dataset.
The y-intercept, the estimated value of Asin_sqrtSurvival when OWmeanpH is zero, is 2.8186 with a standard error of 2.4464. The slope, the estimated change in Asin_sqrtSurvival per unit change in OWmeanpH, is -0.2419 with a standard error of 0.3251. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in OWmeanpH, is 0.0647. The correlation between Asin_sqrtSurvival and OWmeanpH is -0.2544.

A significance test that the slope is zero resulted in a t-value of -0.7441. The significance level of this t-test is 0.4781. Since $0.4781 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.2419. The lower limit of the 95% confidence interval for the slope is -0.9917 and the upper limit is 0.5078. The estimated intercept is 2.8186. The lower limit of the 95% confidence interval for the intercept is -2.8227 and the upper limit is 8.4600.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	OWmeanpH
Count	10	10
Mean	0.9992	7.5200
Standard Deviation	0.2488	0.2616
Minimum	0.5380	7.0000
Maximum	1.3180	7.9000

Linear Regression Report

Page/Date/Time 3 9/21/2009 10:36:53 AM

Database

Y = Asin_sqrtSurvival X = OWmeanpH

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	2.8186	-0.2419
Lower 95% Confidence Limit	-2.8227	-0.9917
Upper 95% Confidence Limit	8.4600	0.5078
Standard Error	2.4464	0.3251
Standardized Coefficient	0.0000	-0.2544
T Value	1.1522	-0.7441
Prob Level (T Test)	0.2825	0.4781
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.1746	0.1010
Regression of Y on X	2.8186	-0.2419
Inverse Regression from X on Y	29.1043	-3.7374
Orthogonal Regression of Y and X	7.1770	-0.8215

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(2.81864935065041) + (-.241948051948216) * (OWmeanpH)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	3.605994E-02	3.605994E-02	0.5537	0.4781	0.1010
Error	8	0.5209597	6.511996E-02			
Lack of Fit	4	0.4731157	0.1182789	9.8887	0.0238	
Pure Error	4	0.047844	0.011961			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(6.511996E-02) = 0.2551861

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/21/2009 10:36:53 AM

Database

Y = Asin_sqrtSurvival X = OWmeanpH

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9196	0.353612	Yes
Anderson Darling	0.3627	0.442185	Yes
D'Agostino Skewness	-0.7331	0.463473	Yes
D'Agostino Kurtosis	-1.0409	0.297900	Yes
D'Agostino Omnibus	1.6211	0.444620	Yes
Constant Residual Variance?			
Modified Levene Test	0.0598	0.813032	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(4, 4) Test	9.8887	0.023754	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

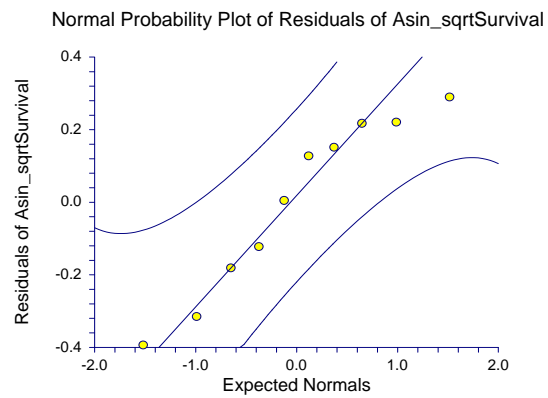
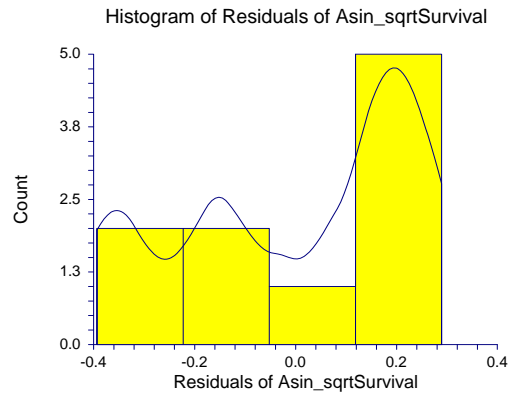
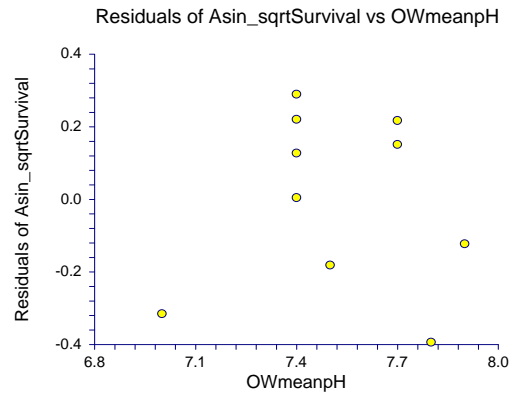
Linear Regression Report

Page/Date/Time 5 9/21/2009 10:36:53 AM

Database

Y = Asin_sqrtSurvival X = OWmeanpH

Residual Plots Section



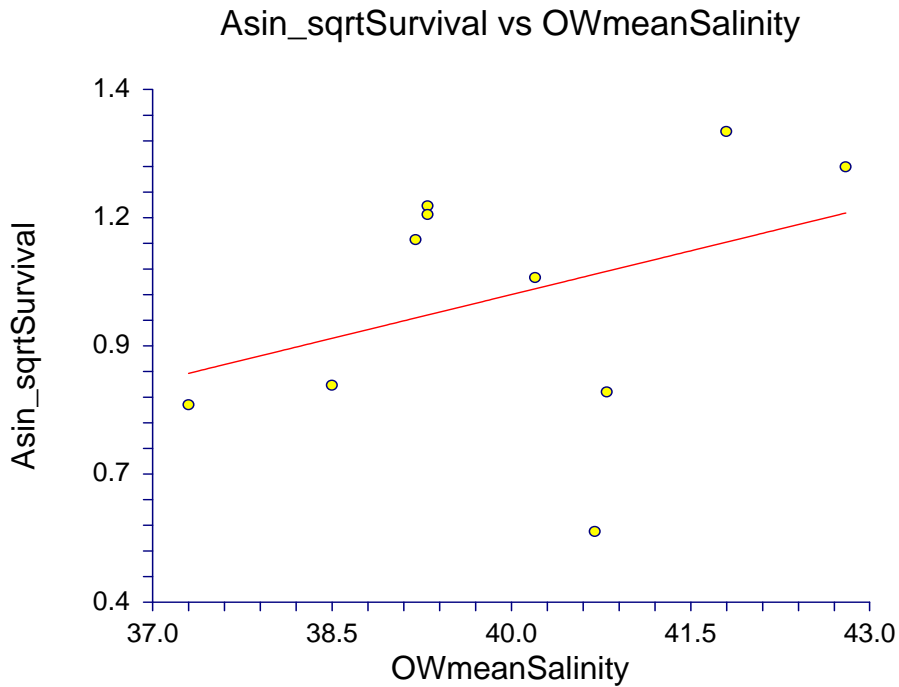
Linear Regression Report

Page/Date/Time 1 9/21/2009 10:37:13 AM

Database

Y = Asin_sqrtSurvival X = OWmeanSalinity

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	OWmeanSalinity	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	-1.2743	Rows Prediction Only	0
Slope	0.0569	Sum of Frequencies	10
R-Squared	0.1358	Sum of Weights	10.0000
Correlation	0.3685	Coefficient of Variation	0.2455
Mean Square Error	6.017018E-02	Square Root of MSE	0.2452961

Linear Regression Report

Page/Date/Time 2 9/21/2009 10:37:13 AM
Y = Asin_sqrtSurvival X = OWmeanSalinity

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and OWmeanSalinity is estimated as: $\text{Asin_sqrtSurvival} = (-1.2743) + (0.0569) \text{OWmeanSalinity}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when OWmeanSalinity is zero, is -1.2743 with a standard error of 2.0289. The slope, the estimated change in Asin_sqrtSurvival per unit change in OWmeanSalinity, is 0.0569 with a standard error of 0.0507. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in OWmeanSalinity, is 0.1358. The correlation between Asin_sqrtSurvival and OWmeanSalinity is 0.3685.

A significance test that the slope is zero resulted in a t-value of 1.1213. The significance level of this t-test is 0.2947. Since $0.2947 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0569. The lower limit of the 95% confidence interval for the slope is -0.0601 and the upper limit is 0.1738. The estimated intercept is -1.2743. The lower limit of the 95% confidence interval for the intercept is -5.9530 and the upper limit is 3.4045.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	OWmeanSalinity
Count	10	10
Mean	0.9992	39.9900
Standard Deviation	0.2488	1.6128
Minimum	0.5380	37.3000
Maximum	1.3180	42.8000

Linear Regression Report

Page/Date/Time 3 9/21/2009 10:37:13 AM

Database

Y = Asin_sqrtSurvival X = OWmeanSalinity

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	-1.2743	0.0569
Lower 95% Confidence Limit	-5.9530	-0.0601
Upper 95% Confidence Limit	3.4045	0.1738
Standard Error	2.0289	0.0507
Standardized Coefficient	0.0000	0.3685
T Value	-0.6280	1.1213
Prob Level (T Test)	0.5475	0.2947
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.0861	0.1679
Regression of Y on X	-1.2743	0.0569
Inverse Regression from X on Y	-15.7388	0.4186
Orthogonal Regression of Y and X	-1.3218	0.0580

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

$(-1.27426284762335) + (5.68507838865524E-02) * (OWmeanSalinity)$

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	7.565816E-02	7.565816E-02	1.2574	0.2947	0.1679
Error	8	0.4813614	6.017018E-02			
Lack of Fit	7	0.4812169	6.874528E-02	475.7459	0.0353	
Pure Error	1	0.0001445	0.0001445			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

$s = \text{Square Root}(6.017018E-02) = 0.2452961$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/21/2009 10:37:13 AM
Database
Y = Asin_sqrtSurvival X = OWmeanSalinity

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.8770	0.120463	No
Anderson Darling	0.4747	0.240563	Yes
D'Agostino Skewness	-1.7735	0.076148	No
D'Agostino Kurtosis	1.0146	0.310283	Yes
D'Agostino Omnibus	4.1747	0.124014	No

Constant Residual Variance?

Modified Levene Test	0.8699	0.378272	Yes
----------------------	--------	----------	-----

Relationship is a Straight Line?

Lack of Linear Fit F(7, 1) Test	475.7459	0.035287	No
---------------------------------	----------	----------	----

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

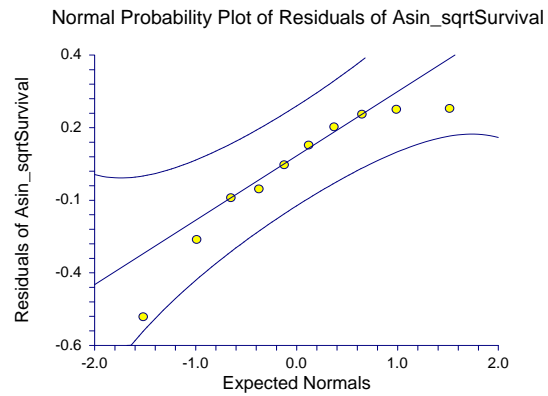
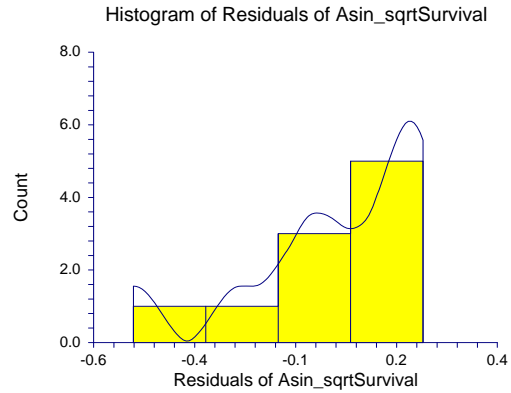
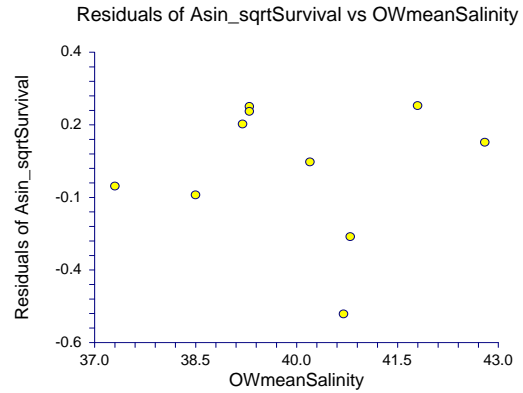
Linear Regression Report

Page/Date/Time 5 9/21/2009 10:37:13 AM

Database

Y = Asin_sqrtSurvival X = OWmeanSalinity

Residual Plots Section



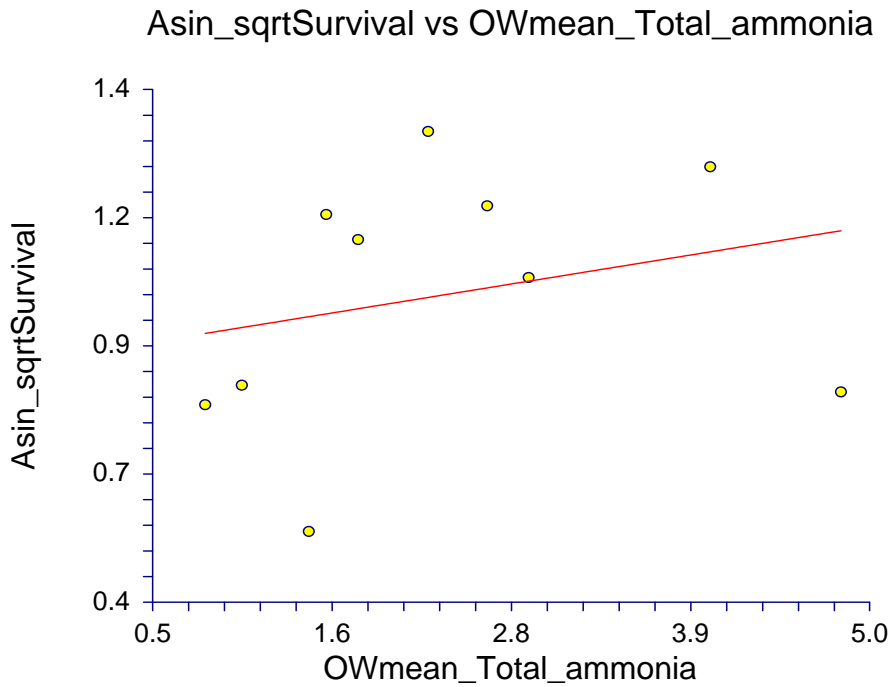
Linear Regression Report

Page/Date/Time 1 9/21/2009 10:37:34 AM

Database

Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	OWmean_Total_ammonia	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.8824	Rows Prediction Only	0
Slope	0.0502	Sum of Frequencies	10
R-Squared	0.0669	Sum of Weights	10.0000
Correlation	0.2586	Coefficient of Variation	0.2551
Mean Square Error	6.497191E-02	Square Root of MSE	0.2548959

Linear Regression Report

Page/Date/Time 2 9/21/2009 10:37:34 AM

Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and OWmean_Total_ammonia is estimated as: $\text{Asin_sqrtSurvival} = (0.8824) + (0.0502) \text{OWmean_Total_ammonia}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when OWmean_Total_ammonia is zero, is 0.8824 with a standard error of 0.1740. The slope, the estimated change in Asin_sqrtSurvival per unit change in OWmean_Total_ammonia, is 0.0502 with a standard error of 0.0663. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in OWmean_Total_ammonia, is 0.0669. The correlation between Asin_sqrtSurvival and OWmean_Total_ammonia is 0.2586.

A significance test that the slope is zero resulted in a t-value of 0.7571. The significance level of this t-test is 0.4707. Since $0.4707 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0502. The lower limit of the 95% confidence interval for the slope is -0.1027 and the upper limit is 0.2031. The estimated intercept is 0.8824. The lower limit of the 95% confidence interval for the intercept is 0.4811 and the upper limit is 1.2837.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	OWmean_Total_ammonia
Count	10	10
Mean	0.9992	2.3260
Standard Deviation	0.2488	1.2814
Minimum	0.5380	0.8300
Maximum	1.3180	4.8200

Linear Regression Report

Page/Date/Time 3 9/21/2009 10:37:34 AM

Database

Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.8824	0.0502
Lower 95% Confidence Limit	0.4811	-0.1027
Upper 95% Confidence Limit	1.2837	0.2031
Standard Error	0.1740	0.0663
Standardized Coefficient	0.0000	0.2586
T Value	5.0707	0.7571
Prob Level (T Test)	0.0010	0.4707
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9927	0.1028
Regression of Y on X	0.8824	0.0502
Inverse Regression from X on Y	-0.7472	0.7508
Orthogonal Regression of Y and X	0.8782	0.0520

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.882426842901652) + (5.02034209365214E-02) * (OWmean_Total_ammonia)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	3.724431E-02	3.724431E-02	0.5732	0.4707	0.1028
Error	8	0.5197753	6.497191E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(6.497191E-02) = 0.2548959

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/21/2009 10:37:34 AM

Database

Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9347	0.495536	Yes
Anderson Darling	0.3514	0.469328	Yes
D'Agostino Skewness	-0.8439	0.398705	Yes
D'Agostino Kurtosis	-0.4586	0.646549	Yes
D'Agostino Omnibus	0.9225	0.630493	Yes
Constant Residual Variance?			
Modified Levene Test	0.0266	0.874449	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

Linear Regression Report

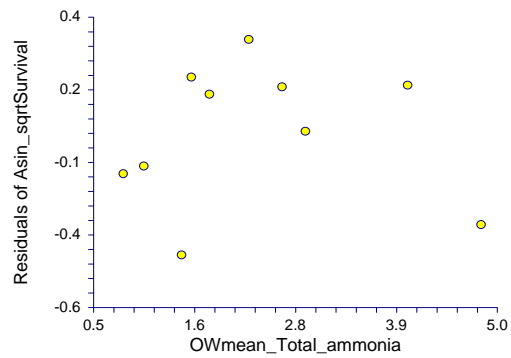
Page/Date/Time 5 9/21/2009 10:37:34 AM

Database

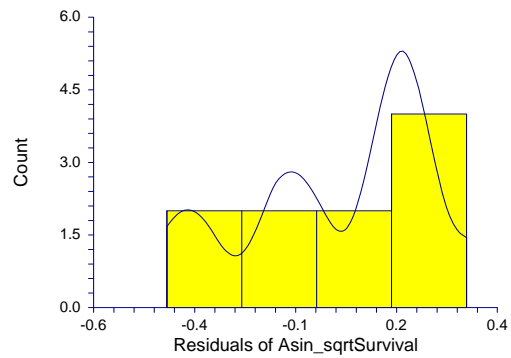
Y = Asin_sqrtSurvival X = OWmean_Total_ammonia

Residual Plots Section

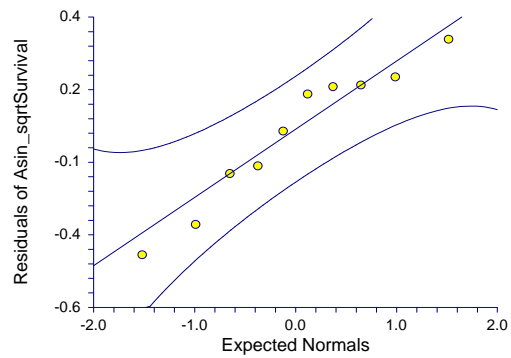
Residuals of Asin_sqrtSurvival vs OWmean_Total_ammonia



Histogram of Residuals of Asin_sqrtSurvival



Normal Probability Plot of Residuals of Asin_sqrtSurvival



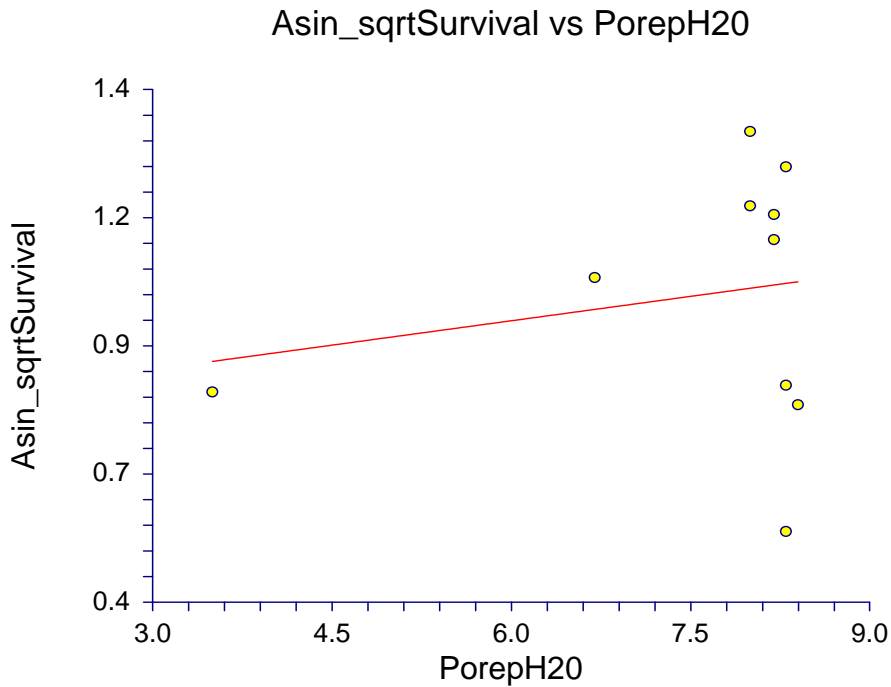
Linear Regression Report

Page/Date/Time 1 9/21/2009 10:45:02 AM

Database

Y = Asin_sqrtSurvival X = PorepH20

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	PorepH20	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.7586	Rows Prediction Only	0
Slope	0.0317	Sum of Frequencies	10
R-Squared	0.0375	Sum of Weights	10.0000
Correlation	0.1936	Coefficient of Variation	0.2591
Mean Square Error	6.701829E-02	Square Root of MSE	0.2588789

Linear Regression Report

Page/Date/Time 2 9/21/2009 10:45:02 AM
Y = Asin_sqrtSurvival X = PorepH20

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and PorepH20 is estimated as:
 $\text{Asin_sqrtSurvival} = (0.7586) + (0.0317) \text{ PorepH20}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when PorepH20 is zero, is 0.7586 with a standard error of 0.4389. The slope, the estimated change in Asin_sqrtSurvival per unit change in PorepH20, is 0.0317 with a standard error of 0.0568. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in PorepH20, is 0.0375. The correlation between Asin_sqrtSurvival and PorepH20 is 0.1936.

A significance test that the slope is zero resulted in a t-value of 0.5581. The significance level of this t-test is 0.5921. Since $0.5921 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0317. The lower limit of the 95% confidence interval for the slope is -0.0993 and the upper limit is 0.1627. The estimated intercept is 0.7586. The lower limit of the 95% confidence interval for the intercept is -0.2534 and the upper limit is 1.7706.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	PorepH20
Count	10	10
Mean	0.9992	7.5900
Standard Deviation	0.2488	1.5191
Minimum	0.5380	3.5000
Maximum	1.3180	8.4000

Linear Regression Report

Page/Date/Time 3 9/21/2009 10:45:02 AM

Database

Y = Asin_sqrtSurvival X = PorepH20

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.7586	0.0317
Lower 95% Confidence Limit	-0.2534	-0.0993
Upper 95% Confidence Limit	1.7706	0.1627
Standard Error	0.4389	0.0568
Standardized Coefficient	0.0000	0.1936
T Value	1.7285	0.5581
Prob Level (T Test)	0.1222	0.5921
Reject H0 (Alpha = 0.0500)	No	No
Power (Alpha = 0.0500)	0.3315	0.0784
Regression of Y on X	0.7586	0.0317
Inverse Regression from X on Y	-5.4219	0.8460
Orthogonal Regression of Y and X	0.7522	0.0325

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.758581395348843) + (3.17020559487693E-02) * (PorepH20)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	2.087327E-02	2.087327E-02	0.3115	0.5921	0.0784
Error	8	0.5361463	6.701829E-02			
Lack of Fit	4	0.2683593	6.708983E-02	1.0021	0.4992	
Pure Error	4	0.267787	6.694675E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(6.701829E-02) = 0.2588789

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/21/2009 10:45:02 AM

Database

Y = Asin_sqrtSurvival X = PorepH20

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9374	0.524987	Yes
Anderson Darling	0.3201	0.532523	Yes
D'Agostino Skewness	-1.2320	0.217959	Yes
D'Agostino Kurtosis	0.2764	0.782219	Yes
D'Agostino Omnibus	1.5942	0.450640	Yes
Constant Residual Variance?			
Modified Levene Test	1.6429	0.235831	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(4, 4) Test	1.0021	0.499199	Yes

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

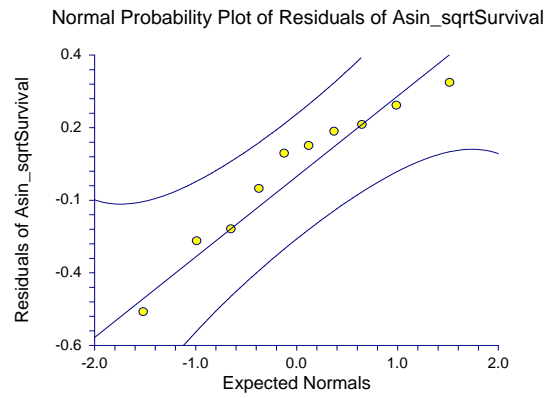
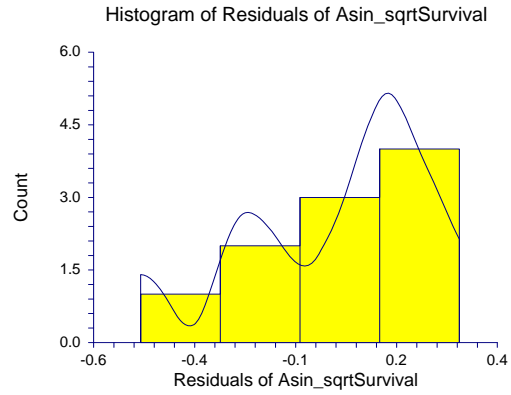
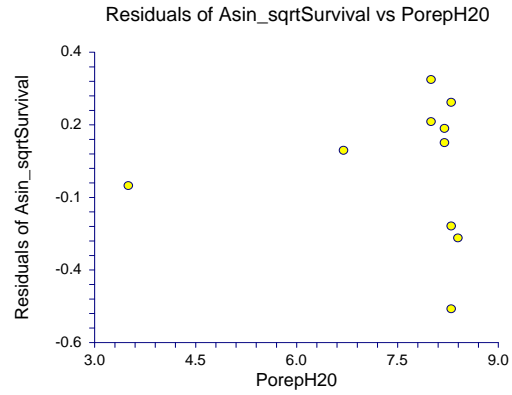
Linear Regression Report

Page/Date/Time 5 9/21/2009 10:45:02 AM

Database

Y = Asin_sqrtSurvival X = PorepH20

Residual Plots Section



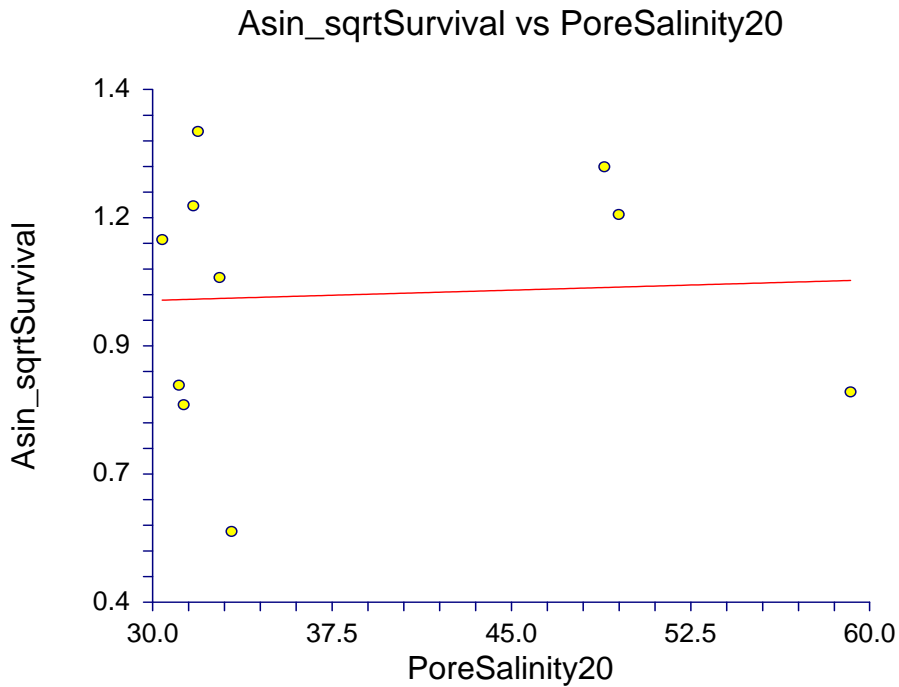
Linear Regression Report

Page/Date/Time 1 9/21/2009 10:45:28 AM

Database

Y = Asin_sqrtSurvival X = PoreSalinity20

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	PoreSalinity20	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.9487	Rows Prediction Only	0
Slope	0.0013	Sum of Frequencies	10
R-Squared	0.0031	Sum of Weights	10.0000
Correlation	0.0557	Coefficient of Variation	0.2637
Mean Square Error	6.941155E-02	Square Root of MSE	0.2634607

Linear Regression Report

Page/Date/Time 2 9/21/2009 10:45:28 AM
Y = Asin_sqrtSurvival X = PoreSalinity20

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and PoreSalinity20 is estimated as: $\text{Asin_sqrtSurvival} = (0.9487) + (0.0013) \text{PoreSalinity20}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when PoreSalinity20 is zero, is 0.9487 with a standard error of 0.3311. The slope, the estimated change in Asin_sqrtSurvival per unit change in PoreSalinity20, is 0.0013 with a standard error of 0.0084. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in PoreSalinity20, is 0.0031. The correlation between Asin_sqrtSurvival and PoreSalinity20 is 0.0557.

A significance test that the slope is zero resulted in a t-value of 0.1577. The significance level of this t-test is 0.8786. Since $0.8786 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is 0.0013. The lower limit of the 95% confidence interval for the slope is -0.0181 and the upper limit is 0.0208. The estimated intercept is 0.9487. The lower limit of the 95% confidence interval for the intercept is 0.1852 and the upper limit is 1.7121.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	PoreSalinity20
Count	10	10
Mean	0.9992	38.0100
Standard Deviation	0.2488	10.4179
Minimum	0.5380	30.4000
Maximum	1.3180	59.2000

Linear Regression Report

Page/Date/Time 3 9/21/2009 10:45:28 AM

Database

Y = Asin_sqrtSurvival X = PoreSalinity20

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	0.9487	0.0013
Lower 95% Confidence Limit	0.1852	-0.0181
Upper 95% Confidence Limit	1.7121	0.0208
Standard Error	0.3311	0.0084
Standardized Coefficient	0.0000	0.0557
T Value	2.8654	0.1577
Prob Level (T Test)	0.0210	0.8786
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.7095	0.0522
Regression of Y on X	0.9487	0.0013
Inverse Regression from X on Y	-15.3012	0.4288
Orthogonal Regression of Y and X	0.9486	0.0013

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(.948656403788333) + (1.32974470433211E-03) * (PoreSalinity20)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	1.727179E-03	1.727179E-03	0.0249	0.8786	0.0522
Error	8	0.5552924	6.941155E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

$s = \text{Square Root}(6.941155E-02) = 0.2634607$

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/21/2009 10:45:28 AM

Database

Y = Asin_sqrtSurvival X = PoreSalinity20

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9375	0.525686	Yes
Anderson Darling	0.3464	0.481949	Yes
D'Agostino Skewness	-0.8032	0.421855	Yes
D'Agostino Kurtosis	-0.4092	0.682385	Yes
D'Agostino Omnibus	0.8126	0.666112	Yes
Constant Residual Variance?			
Modified Levene Test	0.1031	0.756321	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

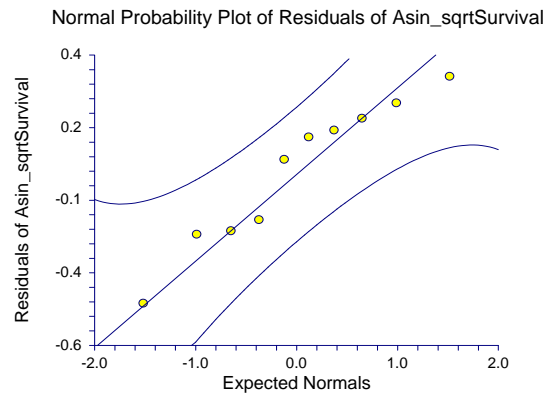
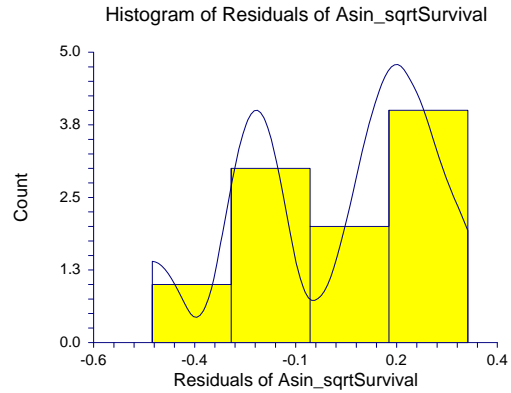
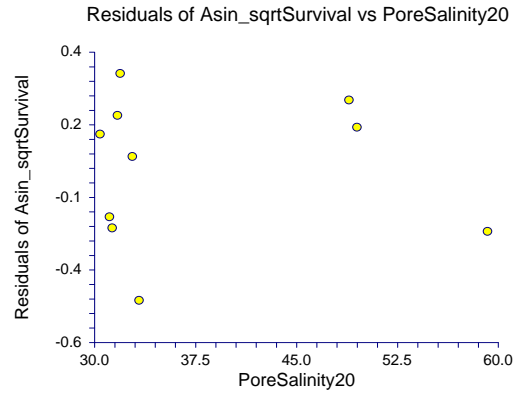
Linear Regression Report

Page/Date/Time 5 9/21/2009 10:45:28 AM

Database

Y = Asin_sqrtSurvival X = PoreSalinity20

Residual Plots Section



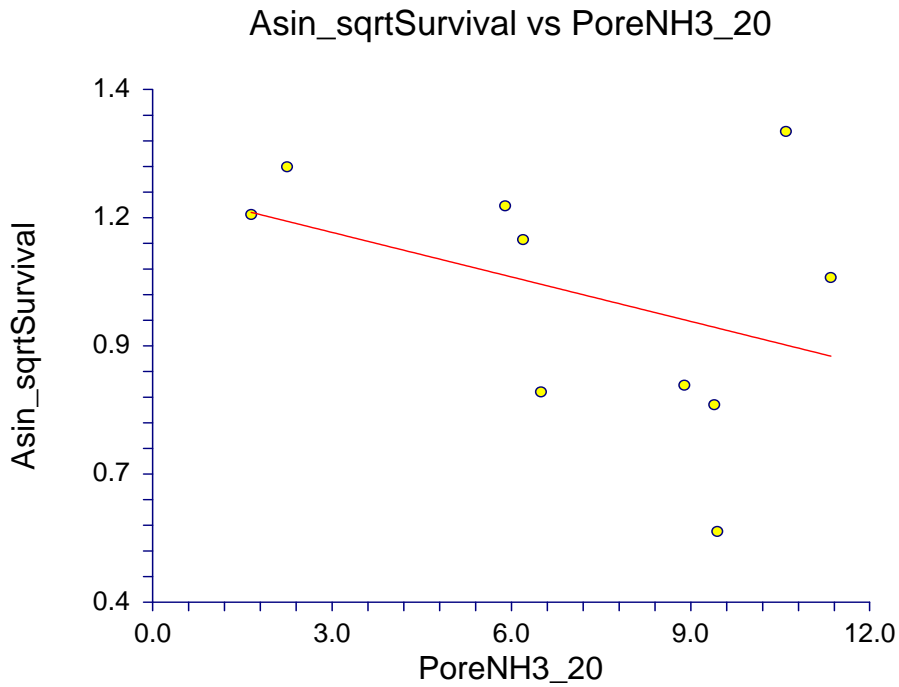
Linear Regression Report

Page/Date/Time 1 9/21/2009 10:45:49 AM

Database

Y = Asin_sqrtSurvival X = PoreNH3_20

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	PoreNH3_20	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.2079	Rows Prediction Only	0
Slope	-0.0289	Sum of Frequencies	10
R-Squared	0.1501	Sum of Weights	10.0000
Correlation	-0.3874	Coefficient of Variation	0.2435
Mean Square Error	5.917626E-02	Square Root of MSE	0.2432617

Linear Regression Report

Page/Date/Time 2 9/21/2009 10:45:49 AM
Y = Asin_sqrtSurvival X = PoreNH3_20

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and PoreNH3_20 is estimated as:
 $\text{Asin_sqrtSurvival} = (1.2079) + (-0.0289) \text{PoreNH3_20}$ using the 10 observations in this dataset.
The y-intercept, the estimated value of Asin_sqrtSurvival when PoreNH3_20 is zero, is 1.2079 with a standard error of 0.1917. The slope, the estimated change in Asin_sqrtSurvival per unit change in PoreNH3_20, is -0.0289 with a standard error of 0.0243. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in PoreNH3_20, is 0.1501. The correlation between Asin_sqrtSurvival and PoreNH3_20 is -0.3874.

A significance test that the slope is zero resulted in a t-value of -1.1887. The significance level of this t-test is 0.2687. Since $0.2687 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.0289. The lower limit of the 95% confidence interval for the slope is -0.0850 and the upper limit is 0.0272. The estimated intercept is 1.2079. The lower limit of the 95% confidence interval for the intercept is 0.7659 and the upper limit is 1.6500.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	PoreNH3_20
Count	10	10
Mean	0.9992	7.2200
Standard Deviation	0.2488	3.3343
Minimum	0.5380	1.6500
Maximum	1.3180	11.3500

Linear Regression Report

Page/Date/Time 3 9/21/2009 10:45:49 AM

Database

Y = Asin_sqrtSurvival X = PoreNH3_20

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.2079	-0.0289
Lower 95% Confidence Limit	0.7659	-0.0850
Upper 95% Confidence Limit	1.6500	0.0272
Standard Error	0.1917	0.0243
Standardized Coefficient	0.0000	-0.3874
T Value	6.3011	-1.1887
Prob Level (T Test)	0.0002	0.2687
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	0.9997	0.1828
Regression of Y on X	1.2079	-0.0289
Inverse Regression from X on Y	2.3897	-0.1926
Orthogonal Regression of Y and X	1.2089	-0.0290

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.2079100703606) + (-2.89072119613017E-02) * (PoreNH3_20)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	8.360948E-02	8.360948E-02	1.4129	0.2687	0.1828
Error	8	0.4734101	5.917626E-02			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(5.917626E-02) = 0.2432617

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/21/2009 10:45:49 AM

Database

Y = Asin_sqrtSurvival X = PoreNH3_20

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9754	0.936175	Yes
Anderson Darling	0.2189	0.838342	Yes
D'Agostino Skewness	0.0482	0.961520	Yes
D'Agostino Kurtosis	0.4192	0.675042	Yes
D'Agostino Omnibus	0.1781	0.914805	Yes
Constant Residual Variance?			
Modified Levene Test	1.3978	0.271040	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(0, 0) Test	0.0000	0.000000	No

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

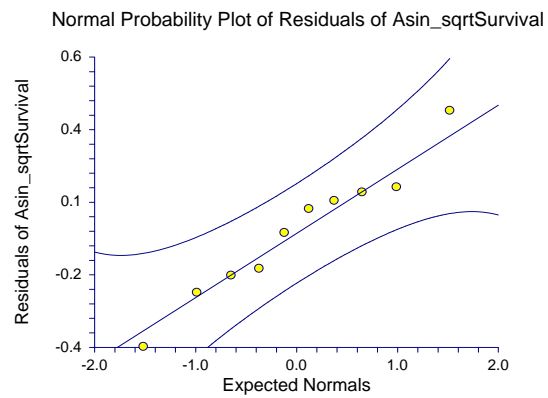
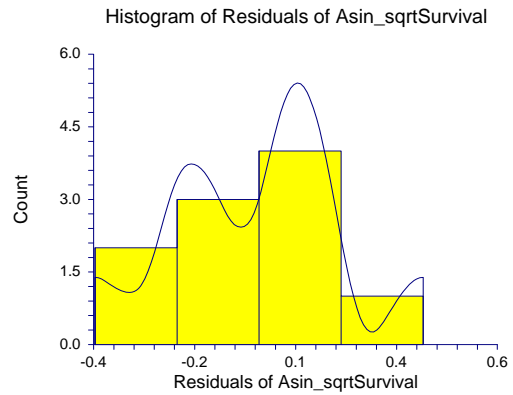
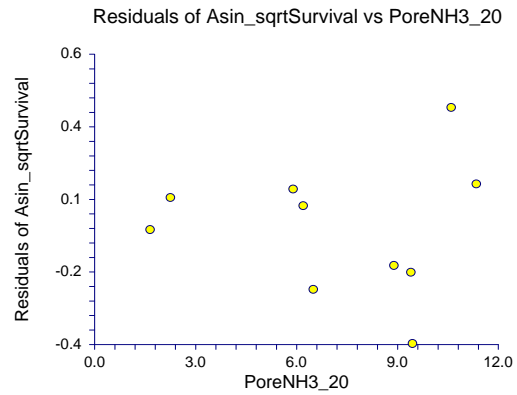
Linear Regression Report

Page/Date/Time 5 9/21/2009 10:45:49 AM

Database

Y = Asin_sqrtSurvival X = PoreNH3_20

Residual Plots Section



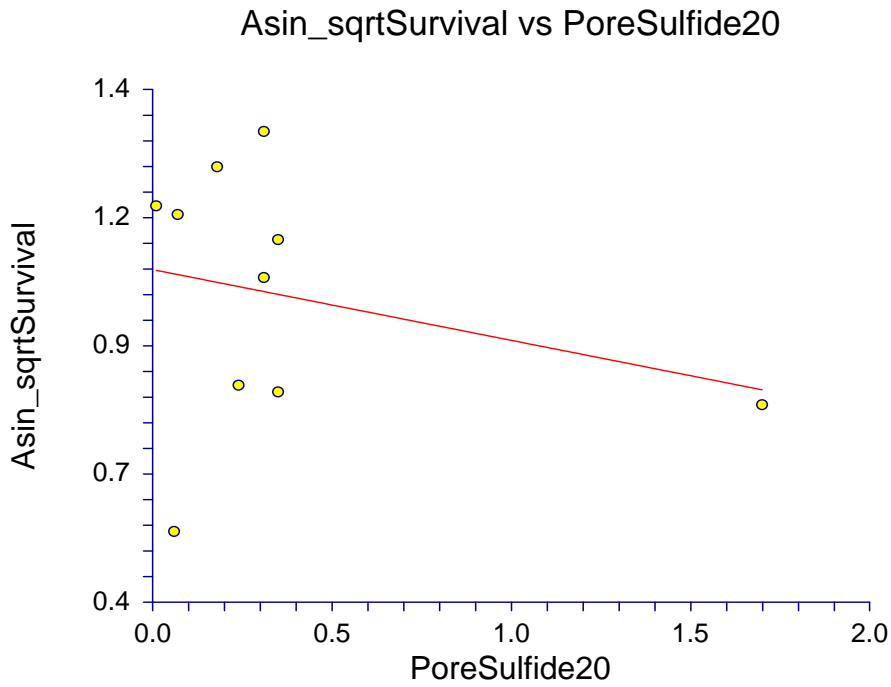
Linear Regression Report

Page/Date/Time 1 9/22/2009 11:55:59 AM

Database

Y = Asin_sqrtSurvival X = PoreSulfide20

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Independent Variable	PoreSulfide20	Rows Used in Estimation	10
Frequency Variable	None	Rows with X Missing	1
Weight Variable	None	Rows with Freq Missing	0
Intercept	1.0486	Rows Prediction Only	0
Slope	-0.1379	Sum of Frequencies	10
R-Squared	0.0732	Sum of Weights	10.0000
Correlation	-0.2705	Coefficient of Variation	0.2542
Mean Square Error	6.453321E-02	Square Root of MSE	0.2540339

Linear Regression Report

Page/Date/Time 2 9/22/2009 11:55:59 AM
Y = Asin_sqrtSurvival X = PoreSulfide20

Summary Statement

The equation of the straight line relating Asin_sqrtSurvival and PoreSulfide20 is estimated as:
 $\text{Asin_sqrtSurvival} = (1.0486) + (-0.1379) \text{PoreSulfide20}$ using the 10 observations in this dataset. The y-intercept, the estimated value of Asin_sqrtSurvival when PoreSulfide20 is zero, is 1.0486 with a standard error of 0.1015. The slope, the estimated change in Asin_sqrtSurvival per unit change in PoreSulfide20, is -0.1379 with a standard error of 0.1735. The value of R-Squared, the proportion of the variation in Asin_sqrtSurvival that can be accounted for by variation in PoreSulfide20, is 0.0732. The correlation between Asin_sqrtSurvival and PoreSulfide20 is -0.2705.

A significance test that the slope is zero resulted in a t-value of -0.7947. The significance level of this t-test is 0.4497. Since $0.4497 > 0.0500$, the hypothesis that the slope is zero is not rejected.

The estimated slope is -0.1379. The lower limit of the 95% confidence interval for the slope is -0.5379 and the upper limit is 0.2622. The estimated intercept is 1.0486. The lower limit of the 95% confidence interval for the intercept is 0.8144 and the upper limit is 1.2827.

Descriptive Statistics Section

Parameter	Dependent	Independent
Variable	Asin_sqrtSurvival	PoreSulfide20
Count	10	10
Mean	0.9992	0.3580
Standard Deviation	0.2488	0.4881
Minimum	0.5380	0.0100
Maximum	1.3180	1.7000

Linear Regression Report

Page/Date/Time 3 9/22/2009 11:55:59 AM

Database

Y = Asin_sqrtSurvival X = PoreSulfide20

Regression Estimation Section

Parameter	Intercept B(0)	Slope B(1)
Regression Coefficients	1.0486	-0.1379
Lower 95% Confidence Limit	0.8144	-0.5379
Upper 95% Confidence Limit	1.2827	0.2622
Standard Error	0.1015	0.1735
Standardized Coefficient	0.0000	-0.2705
T Value	10.3264	-0.7947
Prob Level (T Test)	0.0000	0.4497
Reject H0 (Alpha = 0.0500)	Yes	No
Power (Alpha = 0.0500)	1.0000	0.1083
Regression of Y on X	1.0486	-0.1379
Inverse Regression from X on Y	1.6738	-1.8843
Orthogonal Regression of Y and X	1.0637	-0.1802

Notes:

The above report shows the least-squares estimates of the intercept and slope followed by the corresponding standard errors, confidence intervals, and hypothesis tests. Note that these results are based on several assumptions that should be validated before they are used.

Estimated Model

(1.04855590067905) + (-.137865644354899) * (PoreSulfide20)

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	9.984006	9.984006			
Slope	1	4.075391E-02	4.075391E-02	0.6315	0.4497	0.1083
Error	8	0.5162657	6.453321E-02			
Lack of Fit	6	0.4315487	7.192478E-02	1.6980	0.4159	
Pure Error	2	0.084717	0.0423585			
Adj. Total	9	0.5570196	6.189107E-02			
Total	10	10.54103				

s = Square Root(6.453321E-02) = 0.2540339

Notes:

The above report shows the F-Ratio for testing whether the slope is zero, the degrees of freedom, and the mean square error. The mean square error, which estimates the variance of the residuals, is used extensively in the calculation of hypothesis tests and confidence intervals.

Linear Regression Report

Page/Date/Time 4 9/22/2009 11:55:59 AM
Database
Y = Asin_sqrtSurvival X = PoreSulfide20

Tests of Assumptions Section

Assumption/Test	Test Value	Prob Level	Is the Assumption Reasonable at the 0.2000 Level of Significance?
Residuals follow Normal Distribution?			
Shapiro Wilk	0.9319	0.466362	Yes
Anderson Darling	0.3503	0.472197	Yes
D'Agostino Skewness	-1.4023	0.160830	No
D'Agostino Kurtosis	0.8294	0.406858	Yes
D'Agostino Omnibus	2.6544	0.265223	Yes
Constant Residual Variance?			
Modified Levene Test	0.4037	0.542919	Yes
Relationship is a Straight Line?			
Lack of Linear Fit F(6, 2) Test	1.6980	0.415924	Yes

No Serial Correlation?

Evaluate the Serial-Correlation report and the Durbin-Watson test if you have equal-spaced, time series data.

Notes:

A 'Yes' means there is not enough evidence to make this assumption seem unreasonable. This lack of evidence may be because the sample size is too small, the assumptions of the test itself are not met, or the assumption is valid.

A 'No' means the that the assumption is not reasonable. However, since these tests are related to sample size, you should assess the role of sample size in the tests by also evaluating the appropriate plots and graphs. A large dataset (say $N > 500$) will often fail at least one of the normality tests because it is hard to find a large dataset that is perfectly normal.

Normality and Constant Residual Variance:

Possible remedies for the failure of these assumptions include using a transformation of Y such as the log or square root, correcting data-recording errors found by looking into outliers, adding additional independent variables, using robust regression, or using bootstrap methods.

Straight-Line:

Possible remedies for the failure of this assumption include using nonlinear regression or polynomial regression.

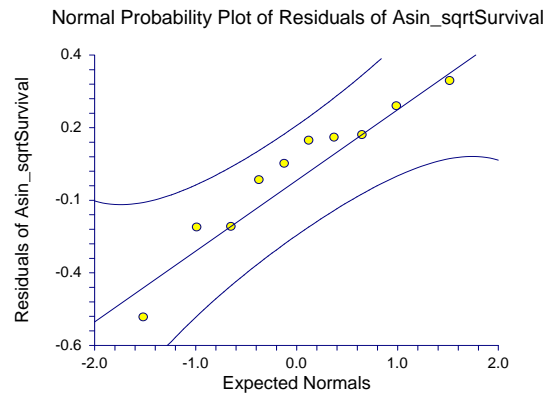
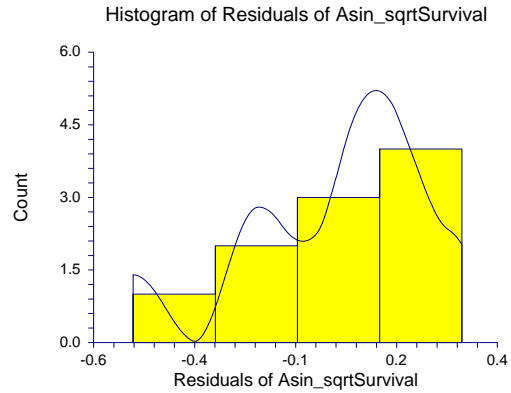
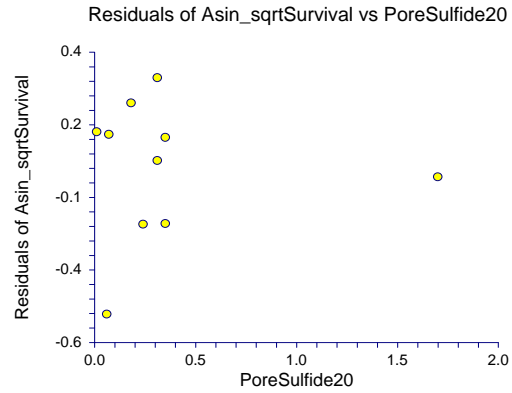
Linear Regression Report

Page/Date/Time 5 9/22/2009 11:55:59 AM

Database

Y = Asin_sqrtSurvival X = PoreSulfide20

Residual Plots Section



**ALL POSSIBLE REGRESSION AND MULTIPLE REGRESSION
REPORTS**

All Possible Regression Report

Page/Date/Time 1 9/22/2009 12:05:45 PM

Database

Dependent Asin_sqrtSurvival

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
1	0.451774	0.1953755	3.164568	E (SEM_AVS)
1	0.444742	0.1966245	3.282121	F (Sand)
1	0.106244	0.2494593	8.940709	D (Zinc)
1	0.032636	0.2595286	10.171209	A (Copper)
1	0.006607	0.2629971	10.606333	B (Lead)
1	0.003456	0.2634138	10.659003	C (Mercury)
2	0.646489	0.1677211	1.909563	CE
2	0.630648	0.1714378	2.174380	BE
2	0.616407	0.1747115	2.412433	DE
2	0.567554	0.1855036	3.229109	AE
2	0.517149	0.1960165	4.071703	EF
2	0.481165	0.2031894	4.673253	CF
2	0.468060	0.2057394	4.892315	AF
2	0.456964	0.2078742	5.077812	DF
2	0.447549	0.2096684	5.235194	BF
2	0.320123	0.2325956	7.365353	CD
3	0.736123	0.1565167	2.411177	ABE
3	0.728991	0.1586177	2.530398	BCE
3	0.704681	0.1655789	2.936774	ACE
3	0.689219	0.1698585	3.195263	DEF
3	0.665854	0.1761278	3.585849	CEF
3	0.663354	0.1767855	3.627640	CDE
3	0.658958	0.1779358	3.701117	BDE
3	0.634690	0.1841579	4.106802	BEF
3	0.624430	0.1867261	4.278319	ADE
3	0.606996	0.1910108	4.569755	ACD
4	0.812876	0.1443826	3.128107	ABEF
4	0.790976	0.1525977	3.494202	ABDE
4	0.768791	0.1604916	3.865062	ABCE
4	0.733181	0.1724086	4.460357	BCDE
4	0.729444	0.1736116	4.522822	BCEF
4	0.710815	0.179489	4.834233	ACEF
4	0.710008	0.1797393	4.847728	ACDE
4	0.701665	0.1823065	4.987192	CDEF
4	0.690636	0.1856459	5.171571	BDEF
4	0.690629	0.1856478	5.171682	ADEF
5	0.820539	0.1580849	5.000011	ABDEF
5	0.819163	0.1586897	5.023010	ABCEF
5	0.795738	0.1686551	5.414609	ABCDE
5	0.737528	0.191182	6.387690	BCDEF

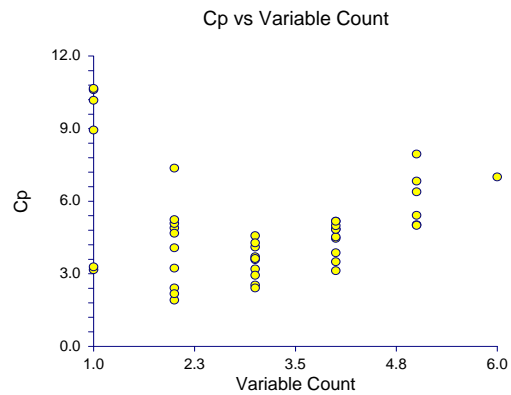
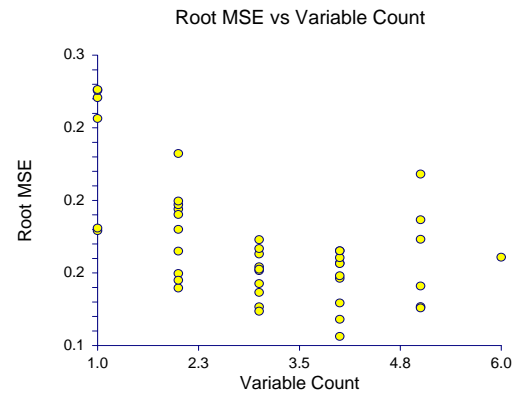
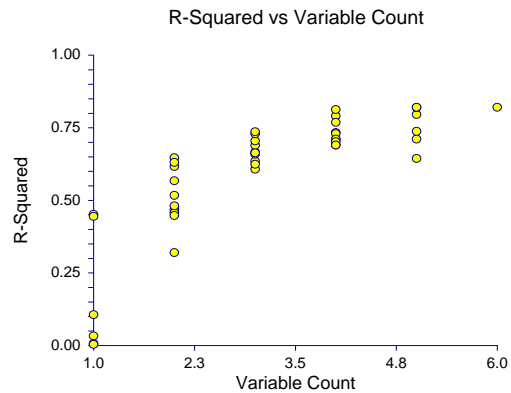
All Possible Regression Report

Page/Date/Time 2 9/22/2009 12:05:45 PM
Database
Dependent Asin_sqrtSurvival

All Possible Results Section

Model Size	R-Squared	Root MSE	Cp	Model
5	0.711011	0.2006069	6.830961	ACDEF
5	0.644045	0.2226399	7.950427	ABCDF
6	0.820540	0.1825404	7.000000	ABCDEF

Plots Section



Multiple Regression Report

Page/Date/Time 1 9/22/2009 12:25:07 PM

Database

Dependent Asin_sqrtSurvival

Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Asin_sqrtSurvival	Rows Processed	11
Number Ind. Variables	4	Rows Filtered Out	0
Weight Variable	None	Rows with X's Missing	1
R2	0.8129	Rows with Weight Missing	0
Adj R2	0.6632	Rows with Y Missing	0
Coefficient of Variation	0.1445	Rows Used in Estimation	10
Mean Square Error	2.084633E-02	Sum of Weights	10.000
Square Root of MSE	0.1443826	Completion Status	Normal Completion
Ave Abs Pct Error	8.933		

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Minimum	Maximum
Copper	10	197.4	204.3685	21	710
Lead	10	135.91	174.9462	1.2	450
Sand	10	21.56	9.815543	8.8	39.2
SEM_AVS	10	27.12787	51.42843	0.1901	161.3828
Asin_sqrtSurvival	10	0.9992	0.2487791	0.538	1.318

Regression Equation Section

Independent Variable	Regression Coefficient b(i)	Standard Error Sb(i)	T-Value to test H0:B(i)=0	Prob Level	Reject H0 at 5%?	Power of Test at 5%
Intercept	0.9010	0.1893	4.759	0.0051	Yes	0.9628
Copper	-0.0036	0.0017	-2.182	0.0809	No	0.4235
Lead	0.0063	0.0026	2.428	0.0595	No	0.5001
Sand	0.0179	0.0125	1.432	0.2115	No	0.2155
SEM_AVS	-0.0157	0.0055	-2.827	0.0368	Yes	0.6224

Estimated Model

.901045891162975-3.62213002930827E-03*Copper+ 6.27799574059806E-03*Lead+ 1.78795147967122E-02*Sand-
1.56872678724618E-02*SEM_AVS

Multiple Regression Report

Page/Date/Time 2 9/22/2009 12:25:07 PM

Database

Dependent Asin_sqrtSurvival

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	0.9010	0.1893	0.4143	1.3877	0.0000
Copper	-0.0036	0.0017	-0.0079	0.0006	-2.9755
Lead	0.0063	0.0026	-0.0004	0.0129	4.4148
Sand	0.0179	0.0125	-0.0142	0.0500	0.7054
SEM_AVS	-0.0157	0.0055	-0.0300	-0.0014	-3.2429

Note: The T-Value used to calculate these confidence limits was 2.571.

Analysis of Variance Section

Source	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		9.984006	9.984006			
Model	4	0.8129	0.452788	0.113197	5.430	0.0459	0.6567
Error	5	0.1871	0.1042316	2.084633E-02			
Total(Adjusted)	9	1.0000	0.5570196	6.189107E-02			

Analysis of Variance Detail Section

Model Term	DF	R2	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1		9.984006	9.984006			
Model	4	0.8129	0.452788	0.113197	5.430	0.0459	0.6567
Copper	1	0.1782	9.925312E-02	9.925312E-02	4.761	0.0809	0.4235
Lead	1	0.2206	0.1228761	0.1228761	5.894	0.0595	0.5001
Sand	1	0.0768	0.0427532	0.0427532	2.051	0.2115	0.2155
SEM_AVS	1	0.2991	0.1666233	0.1666233	7.993	0.0368	0.6224
Error	5	0.1871	0.1042316	2.084633E-02			
Total(Adjusted)	9	1.0000	0.5570196	6.189107E-02			

Normality Tests Section

Test Name	Test Value	Prob Level	Reject H0 At Alpha = 20%?
Shapiro Wilk	0.9102	0.282403	No
Anderson Darling	0.3680	0.429994	No
D'Agostino Skewness	-1.5833	0.113357	Yes
D'Agostino Kurtosis	1.1406	0.254039	No
D'Agostino Omnibus	3.8077	0.148992	Yes

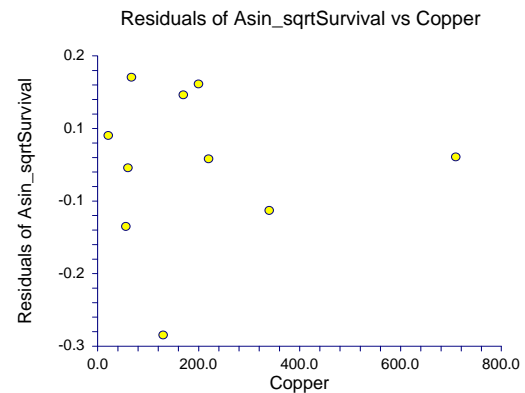
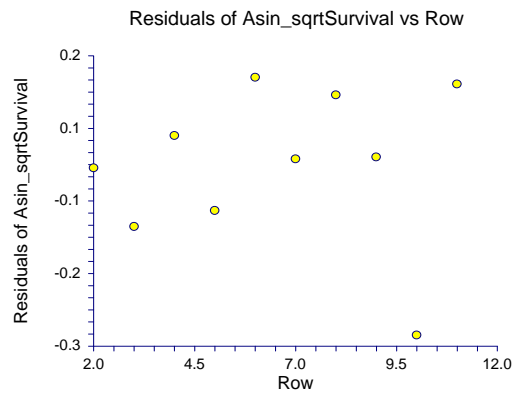
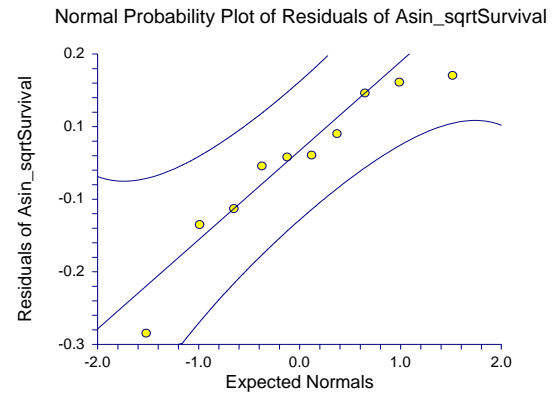
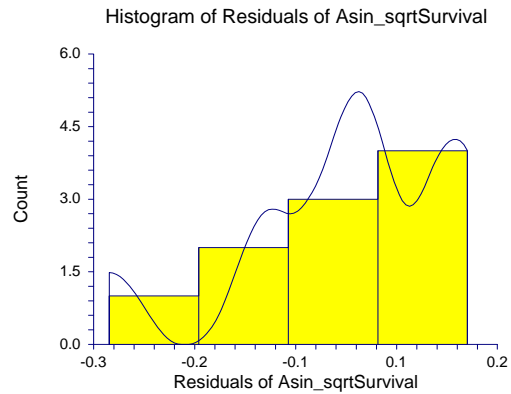
Multiple Regression Report

Page/Date/Time 3 9/22/2009 12:25:07 PM
Database
Dependent Asin_sqrtSurvival

Regression Diagnostics Section

	Standardized		Hat			
Row	Residual	RStudent	Diagonal	Cook's D	Dffits	CovRatio
10	-1.7976	-2.7036	0.1829	0.1446	-1.2789	0.0207
11	1.6786	2.2725	0.7891	2.1090	4.3963	0.2293

Plots Section

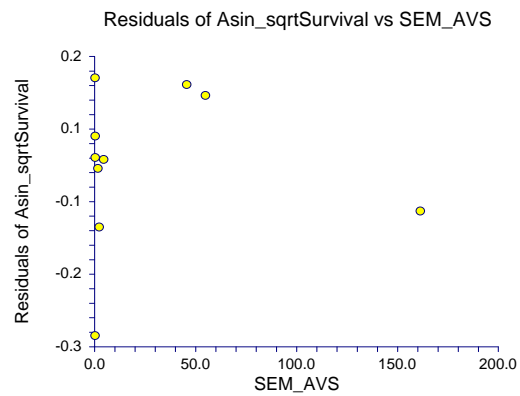
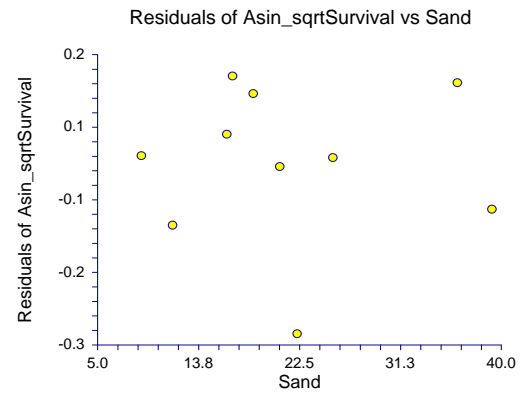
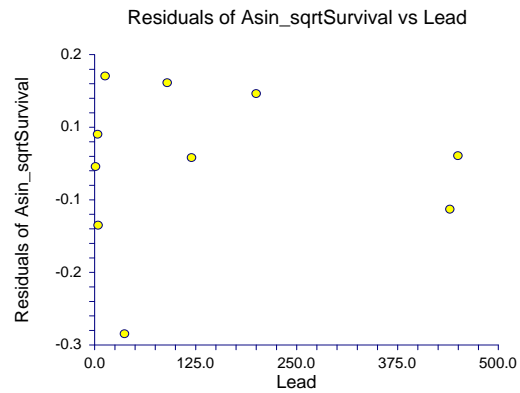


Multiple Regression Report

Page/Date/Time 4 9/22/2009 12:25:07 PM

Database

Dependent Asin_sqrtSurvival



APPENDIX M
95 PERCENT UCL OF THE MEAN ECOLOGICAL COC
CONCENTRATIONS IN SWMU 2 FIDDLER CRAB TISSUE

Lead**SWMU 2 Fiddler Crab Tissue**

General Statistics

Number of Valid Data	8
Number of Distinct Detected Data	6

Number of Detected Data	7
Number of Non-Detect Data	1
Percent Non-Detects	12.50%

Raw Statistics

Minimum Detected	0.462
Maximum Detected	15.77
Mean of Detected	5.401
SD of Detected	7.108
Minimum Non-Detect	0.331
Maximum Non-Detect	0.331

Log-transformed Statistics

Minimum Detected	-0.773
Maximum Detected	2.758
Mean of Detected	0.844
SD of Detected	1.404
Minimum Non-Detect	-1.106
Maximum Non-Detect	-1.106

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.67
5% Shapiro Wilk Critical Value	0.803

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.87
5% Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	4.747
SD	6.836
95% DL/2 (t) UCL	9.326

Maximum Likelihood Estimate(MLE) Method

Mean	4.217
SD	7.022
95% MLE (t) UCL	8.921
95% MLE (Tiku) UCL	8.718

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	0.513
SD	1.601
95% H-Sta	36.47

Log ROS Method

Mean in Log Scale	0.418
SD in Log Scale	1.773
Mean in Original Scale	4.736
SD in Original Scale	6.845
95% Percentile Bootstrap UCL	8.591
95% BCA Bootstrap UCL	10.11

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.504
Theta Star	10.72
nu star	7.051

Data Distribution Test with Detected Values Only

Data Follow Appr. Gamma Distribution at 5% Significance Level

A-D Test Statistic	0.745
5% A-D Critical Value	0.738
K-S Test Statistic	0.738
5% K-S Critical Value	0.323

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	4.784
SD	6.369
SE of Mean	2.432
95% KM (t) UCL	9.391
95% KM (z) UCL	8.784
95% KM (jackknife) UCL	9.32
95% KM (bootstrap t) UCL	44.08
95% KM (BCA) UCL	8.788
95% KM (Percentile Bootstrap) UCL	8.567
95% KM (Chebyshev) UCL	15.38
97.5% KM (Chebyshev) UCL	19.97
99% KM (Chebyshev) UCL	28.98

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	1.00E-09
Maximum	15.77
Mean	4.726
Median	1.346
SD	6.852
k star	0.217
Theta star	21.78
Nu star	3.472
AppChi2	0.525
95% Gamma Approximate UCL	31.26
95% Adjusted Gamma UCL	53.06

Potential UCLs to use:

95% KM (Chebyshev) UCL 15.38

Note: DL/2 is not a recommended method.

General Statistics

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics			Lognormal Distribution Test		
Normal Distribution Test			Shapiro Wilk Test Statistic 0.91		
Shapiro Wilk Test Statistic 0.699			Shapiro Wilk Critical Value 0.818		
Shapiro Wilk Critical Value 0.818			Data appear Lognormal at 5% Significance Level		
Data not Normal at 5% Significance Level			Assuming Lognormal Distribution		
Assuming Normal Distribution			95% H-UCL 0.201		
95% Student's-t UCL 0.159			95% Chebyshev (MVUE) UCL 0.199		
95% UCLs (Adjusted for Skewness)			97.5% Chebyshev (MVUE) UCL 0.244		
95% Adjusted-CLT UCL 0.179			99% Chebyshev (MVUE) UCL 0.331		
95% Modified-t UCL 0.164					
Gamma Distribution Test			Data Distribution		
			Data appear Gamma Distributed at 5% Significance Level		
k star (bias corrected) 1.462					
Theta Star 0.0682			Nonparametric Statistics		
MLE of Mean 0.0996			95% CLT UCL 0.152		
MLE of Standard Deviation 0.0824			95% Jackknife UCL 0.159		
nu star 23.38			95% Standard Bootstrap UCL 0.147		
Approximate Chi Square Value (.05) 13.38			95% Bootstrap-t UCL 0.339		
Adjusted Level of Significance 0.0195			95% Hall's Bootstrap UCL 0.422		
Adjusted Chi Square Value 11.51			95% Percentile Bootstrap UCL 0.156		
			95% BCA Bootstrap UCL 0.175		
Anderson-Darling Test Statistic 0.654			95% Chebyshev(Mean, Sd) UCL 0.237		
Anderson-Darling 5% Critical Value 0.723			97.5% Chebyshev(Mean, Sd) UCL 0.297		
Kolmogorov-Smirnov Test Statistic 0.262			99% Chebyshev(Mean, Sd) UCL 0.414		
Kolmogorov-Smirnov 5% Critical Value 0.297					
Data appear Gamma Distributed at 5% Significance Level			Potential UCL to use:		
Assuming Gamma Distribution			Use 95% Approximate Gamma UCL 0.174		
95% Approximate Gamma UCL 0.174					
95% Adjusted Gamma UCL 0.202					